9. AUXILIARY SYSTEMS

9.1 Fuel Storage and Handling

The following sections describe the U.S. Nuclear Regulatory Commission (NRC) staff's review of the AP1000 fuel storage and handling systems:

- 9.1.1, "New Fuel Storage"
- 9.1.2, "Spent Fuel Storage"
- 9.1.3, "Spent Fuel Pool Cooling and Pool Purification"
- 9.1.4, "Light-Load Handling System (Related to Refueling)"
- 9.1.5, "Overhead Heavy-Load Handling Systems"

9.1.1 New Fuel Storage

The staff has reviewed the AP1000 advanced reactor's new fuel storage capability in accordance with Section 9.1.1, "New Fuel Storage," of NUREG-0800, "Standard Review Plan" (SRP). The staff's acceptance of the new fuel storage facility is contingent on compliance with the following requirements:

- General Design Criterion (GDC) 2, "Design Bases for Protection Against Natural Phenomena," as it relates to the ability of the facility and the structures housing it to withstand the effects of natural phenomena, such as earthquakes

- GDC 5, "Sharing of Structures, Systems, and Components," as it relates to whether shared structures, systems, and components (SSCs) important to safety are capable of performing required safety functions

- GDC 61, "Fuel Storage and Handling and Radioactivity Control," as it relates to the facility design for fuel storage

- GDC 62, "Prevention of Criticality in Fuel Storage and Handling," as it relates to the prevention of criticality

In accordance with SRP Section 9.1.1, compliance with GDC 2 depends on adherence to the guidance of Regulatory Position C.1.1 of Regulatory Guide (RG) 1.29, "Seismic Design Classification," as it relates to the seismic classification of facility components. In accordance with SRP Section 9.1.1, specific criteria necessary to meet the requirements of GDC 61 and 62 are American Nuclear Society (ANS) 57.1-1980, "Design Requirements for Light Water Reactor Fuel Handling Systems," and ANS 57.3-1981, "Design Requirements for New LWR Fuel Storage Facilities," as they relate to preventing criticality and to aspects of the radiological design. In the AP1000 Design Control Document (DCD) Tier 2, Section 9.1.1, "New Fuel Storage," the applicant provides the design bases, a description, and a safety evaluation of the new fuel storage arrangement for the AP1000 design.

In DCD Tier 2, Section 9.1.1.1, "Design Bases," the applicant states that the new fuel will be stored in a high-density rack that includes integral neutron-absorbing material to maintain the required degree of subcriticality. The rack is designed to store fuel of the maximum design-basis enrichment. The rack will include storage locations for 72 fuel assemblies. The rack array will have a center-to-center spacing of 27.7 cm (10.9 in.). This spacing provides the minimum separation between adjacent fuel assemblies that is sufficient to maintain a subcritical array, even if the building is flooded with unborated water or fire extinguishant aerosols, or during any design-basis event. The location of the new fuel storage facility will be within the seismic Category I auxiliary building fuel-handling area. The dry, unlined, approximately 5.2-m (17-ft)-deep reinforced concrete pit is designed to support the new fuel storage rack. The pit floor will support the rack, and the pit wall structures will provide lateral support at the rack top grid structure. The new fuel pit will normally be covered to prevent foreign objects from entering the new fuel storage rack.

In DCD Tier 2, Section 9.1.1.3, “Safety Evaluation,” the applicant provides a safety evaluation to demonstrate that the new fuel storage rack design complies with the design bases. DCD Tier 2, Section 9.1.1.3, also states that the new fuel racks are purchased equipment and that the purchase specification will require the vendor to perform a criticality analysis of the new fuel storage racks. The applicant considered normal and postulated accident conditions, such as flooding with pure water and low-density optimum moderator “misting.” The following design features minimize the possibility of these accidents:

- travel limits on handling equipment capable of carrying loads heavier than fuel components
- rack designed for safe-shutdown earthquake (SSE) conditions
- rack designed for dropped fuel assembly (and handling tool) conditions
- new fuel storage pit cover to protect new fuel from dropped objects and debris

In addition, neither the fuel-handling machine nor the cask-handling crane accesses the new fuel pit. This precludes moving loads greater than that of the fuel components over new fuel assemblies.

The staff performed its review in accordance with the guidance and acceptance criteria in SRP Section 9.1.1. The staff directed its evaluation to determine whether the new fuel storage design complies with the requirements of GDC 2, 5, 61, and 62. On the basis of its review, the staff concludes the following:

- The new fuel storage facility will be located within the seismic Category I auxiliary building fuel-handling area in accordance with DCD Tier 2, Section 9.1.1.2, “Facilities Description.” The new fuel storage rack is designed to meet the seismic Category I guidance of RG 1.29. Therefore, the staff finds that the new fuel storage facility meets the requirements of GDC 2.
- The AP1000 design can be used at either single-unit or multiple-unit sites. Nonetheless, in DCD Tier 2, Section 3.1.1, “Overall Requirements,” the applicant states that the AP1000 design is a single-unit plant and that “if more than one unit were built on the same site, none of the safety-related systems would be shared.” Should a multiple-unit site be proposed, the combined license (COL) applicant referencing the AP1000 design will be required to apply for the evaluation of the units’ compliance with the requirements

of GDC 5, with respect to the capability of shared SSCs important to safety to perform their required safety functions.

- In DCD Tier 2, Section 9.1.1.3, the applicant states that the design of the rack is such that the effective multiplication factor (K_{eff}) remains less than or equal to 0.95 with new fuel of the maximum design-basis enrichment. For a postulated accident condition of flooding the new fuel storage area with unborated water, K_{eff} will not exceed 0.98. DCD Tier 2, Section 4.3.2.6.1, “Criticality Design Method Outside the Reactor,” states that the two principal methods of preventing criticality of fuel assemblies outside the reactor are to limit the fuel assembly array size and limit interaction by fixing the minimum separation between assemblies and/or inserting neutron poisons between assemblies. The design basis for preventing criticality outside the reactor is that, including uncertainties, there is a 95-percent probability at a 95-percent confidence level that the K_{eff} of the fuel assembly array will be less than 0.95, as recommended in ANS 57.1 and ANS 57.3. Therefore, the staff finds that the new fuel facility meets the requirements of GDC 61 and 62.

The staff has completed its review of the new fuel storage facility, including the seismic classification, and the protection of fuel inside the fuel storage pit. The new fuel storage facility is located within the seismic Category I auxiliary building fuel-handling area. The staff finds this acceptable to meet the requirements of GDC 2 related to the ability of the facility and the structures housing it to withstand the effects of natural phenomena, such as earthquakes. In addition, in that the AP1000 is a single-unit design, and a COL applicant must comply with GDC 5 for a multiple-unit site, the staff finds that the design has satisfied the requirements of GDC 5 related to whether shared SSCs important to safety are capable of performing required safety functions. Based on the analysis described above, the staff also finds that the design has met the requirements of GDC 61 related to the facility design for fuel storage and the requirements of GDC 62 related to the prevention of criticality.

9.1.2 Spent Fuel Storage

The staff reviewed the spent fuel storage capability in accordance with SRP Section 9.1.2, “Spent Fuel Storage.” The staff’s acceptance of the spent fuel storage facility is based on compliance with the following requirements:

- GDC 2, as it relates to the ability of the facility and the structures housing it to withstand the effects of natural phenomena, such as earthquakes, tornados, and hurricanes

- GDC 4, “Environmental and Dynamic Effects Design Bases,” as it relates to the ability of the facility and the structures housing it to withstand the effects of external missiles, and internally-generated missiles, pipe whip, jet impingement forces, and adverse environmental conditions associated with pipe breaks, such that safety functions will not be impaired

- GDC 5, as it relates to whether shared SSCs important to safety are capable of performing required safety functions

- GDC 61, as it relates to the facility design for fuel storage and handling of radioactive materials

- GDC 62, as it relates to the prevention of criticality
- GDC 63, “Monitoring Fuel and Waste Storage,” as it relates to monitoring systems provided to detect conditions that could result in the loss of decay heat removal capabilities, to detect excessive radiation levels, and to initiate appropriate safety actions

In accordance with SRP Section 9.1.1, compliance with the requirements of GDC 2 depends on adherence to the guidance of Regulatory Position C.3 of RG 1.13, “Spent Fuel Storage Facility Design Basis”; the applicable portions of RG 1.29 and RG 1.117, “Tornado Design Classification”; and paragraphs 5.1.1, 5.1.3, 5.1.12, 5.3.2, and 5.3.4 of ANS 57.2-1976, “Design Objectives for Light Water Reactor Spent Fuel Storage Facilities at Nuclear Power Stations.” Compliance with the requirements of GDC 4 depends on adherence to the guidance of Regulatory Position C.3 of RG 1.13, as well as RG 1.115, “Protection Against Low-Trajectory Turbine Missiles,” and RG 1.117, and the appropriate paragraphs of ANS 57.2. Compliance with the requirements of GDC 61 depends on adherence to the guidance of Positions C.1 and C.4 of RG 1.13, the appropriate paragraphs of ANS 57.2, and adherence to the fuel storage capacity guidelines noted in Subsection III.1 of SRP Section 9.1.2. Compliance with the requirements of GDC 62 depends on adherence to the guidance of Positions C.1 and C.4 of RG 1.13, as well as the appropriate paragraphs of ANS 57.2. Finally, compliance with the requirements of GDC 63 depends on adherence to the guidance of paragraph 5.4 of ANS 57.2.

In DCD Tier 2, Section 9.1.2, “Spent Fuel Storage,” the applicant presents the design bases, facilities description, and a safety evaluation of the spent fuel storage arrangement. In addition, the applicant indicates that the spent fuel will be stored in high-density racks that include integral, neutron-absorbing material to maintain the required degree of subcriticality. The racks are designed to store fuel of the maximum design-basis enrichment. The rack arrays will have a center-to-center spacing of 27.7 cm (10.9 in.) and storage locations for 619 fuel assemblies. In addition, the rack module will contain integral storage locations for five defective fuel storage containers. The spent fuel storage racks, which will be seismic Category I, will be located within the spent fuel pool (SFP). The racks will consist of an array of cells interconnected to each other at several elevations and to supporting grid structures at the top and bottom elevations. The rack modules will be free-standing, neither anchored to the pool floor nor braced to the pool wall.

The spent fuel storage facility (spent fuel pool) will be within the seismic Category I auxiliary building fuel-handling area. The DCD states that the facility will be protected from the effects of natural phenomena, such as earthquakes, wind, tornados, floods, and external missiles. DCD Tier 2, Section 9.1.1.2, “Facilities Description,” also indicates, and the staff agrees, that internally-generated missiles are of no concern because the fuel-handling area does not contain any credible sources of internally-generated missiles. As a result, the staff has determined that the spent fuel storage design meets the applicable guidance of RGs 1.115 and 1.117.

In DCD Tier 2, Section 9.1.2.3, “Safety Evaluation,” the applicant provides a safety evaluation to demonstrate that the spent fuel storage rack design and location comply with its design bases. The safety evaluation includes postulated accidents and criticality safety assumptions. The applicant considered the following postulated accidents:

- fuel-handling accidents (e.g., dropped fuel assembly)
- uplift force on the fuel racks
- a misplaced fuel assembly

The following design features minimize the possibility of these accidents:

- The design of the cask handling crane (capable of carrying loads heavier than the fuel components) prevents it from carrying loads over the fuel storage area.

- The racks are designed for SSE conditions.

- The racks are designed for dropped fuel assembly (and handling tool) conditions.

- The fuel-handling machine is designed to seismic Category I requirements.

In DCD Tier 2, Section 9.1.2.3, “Safety Evaluation,” the applicant states that the design of the racks is such that K_{eff} remains less than or equal to 0.95 under design-basis conditions, including fuel-handling accidents. DCD Tier 2, Section 4.3.2.6.1, “Criticality Design Method Outside the Reactor,” states that the two principal methods of preventing criticality of fuel assemblies outside the reactor are to (1) limit the fuel assembly array size, and (2) limit interaction by fixing the minimum separation between assemblies and/or inserting neutron poisons between assemblies. The design basis for preventing criticality outside the reactor is that, including uncertainties, there is a 95-percent probability at a 95-percent confidence level that the K_{eff} of the fuel assembly array will be less than 0.95, as recommended in ANS 57.1 and ANS 57.3. Therefore, the staff finds that the spent fuel storage design meets the requirements of GDC 61 and 62.

Section 9.1.3 of this report discusses the staff’s evaluation regarding the spent fuel storage design’s compliance with the requirements of GDC 63.

The staff based its review of DCD Tier 2, Section 9.1.2, on the guidance and acceptance criteria in SRP Section 9.1.2. The staff directed its evaluation at determining whether the spent fuel storage facility complies with the requirements of GDC 2, 4, 5, 61, 62, and 63. Meeting these criteria depends on conformance to Positions C.1, C.3, and C.4 of RG 1.13; applicable portions of RGs 1.29, 1.115, and 1.117; and the appropriate paragraphs of ANS 57.2. On the basis of its review, the staff concludes the following:

- In accordance with Regulatory Position C.3 of RG 1.13, the system design prevents heavy loads from being lifted over the SFP. In addition, the fuel racks are designed to withstand a load drop equivalent to that from a fuel assembly and its associated handling tool when dropped from its operating height.

- In accordance with Regulatory Position C.1 of RG 1.13, RG 1.29, and paragraphs 5.1.1, 5.1.3, 5.1.12, and 5.3.2 of ANS 57.2, the spent fuel storage racks are in the spent fuel storage pool, which is within the seismic Category I auxiliary building fuel-handling area. The auxiliary building is designed to maintain its structural integrity following an SSE and to perform its intended function following a postulated event, such as a fire. The SFP and racks are designed to seismic Category I requirements.

- In accordance with Regulatory Position C.4 of RG 1.13, the spent fuel storage facility is located within the seismic Category I auxiliary building fuel-handling area. The radiologically controlled area ventilation system (VAS) serves this portion of the auxiliary building. The VAS consists of a fuel-handling area ventilation subsystem and an auxiliary/annex building ventilation subsystem. As stated in DCD Tier 2, Table 3.2-3, the VAS is nonseismic. The VAS serves no safety-related function. Section 9.4 of this report discusses the staff's review of the VAS.

For the reasons described above, the staff finds that the spent fuel storage design complies with the requirements of GDC 2, as they relate to the ability of the facility and the structures housing it to withstand the effects of natural phenomena, such as earthquakes, tornados, and hurricanes. The staff finds that the spent fuel storage design complies with the requirements of GDC 4, as they relate to the ability of the facility and the structures housing it to withstand the effects of external missiles, pipe whip, jet impingement forces, and adverse environmental conditions associated with pipe breaks, such that safety functions will not be impaired. DCD Tier 2, Section 9.1.1.2.1, Item E, states, and the staff agrees, that internally-generated missiles are of no concern because the fuel-handling area does not contain any credible sources of internally-generated missiles.

In addition, because the AP1000 is a single-unit design, and a COL applicant must comply with GDC 5 for a multiple-unit site, the staff finds that the spent fuel storage design satisfies the requirements of GDC 5 as they relate to whether shared SSCs important to safety are capable of performing their required safety functions. The staff finds that the spent fuel storage design is in compliance with the requirements of GDC 61, as they relate to the facility design for fuel storage and handling radioactive materials, and GDC 62, as they relate to the prevention of criticality. In addition, the spent fuel storage design complies with the requirements of GDC 63, as discussed in Section 9.1.3 of this report, as they relate to monitoring systems provided to detect conditions that could result in the loss of decay heat removal capabilities, to detect excessive radiation levels, and to initiate appropriate safety actions.

9.1.3 Spent Fuel Pool Cooling and Purification

The staff has reviewed the SFP cooling and purification system (SFPCPS) in accordance with SRP Section 9.1.3, "Spent Fuel Pool Cooling and Cleanup System." The staff's acceptance of the SFPCPS design is based on compliance with the following SRP guidance:

- GDC 2, as it relates to the ability of the system and the structures housing it to withstand the effects of natural phenomena, such as earthquakes, tornados, and hurricanes

- GDC 4, as it relates to the ability of the system and the structures housing it to withstand the effects of external missiles

- GDC 5, as it relates to whether shared SSCs important to safety are capable of performing required safety functions

- GDC 44, "Cooling Water," as it relates to the following:

    – the system's ability to transfer heat loads from safety-related SSCs to a heat sink under both normal operating and accident conditions

  - suitable redundancy of components so that safety functions can be performed assuming a single active failure of a component coincident with a loss of offsite power (LOOP) event

  - the system's ability to isolate components, systems, or piping so that they do not compromise the system's safety function

- GDC 45, "Inspection of Cooling Water System," as it relates to allowing periodic inspection of safety-related components and equipment

- GDC 46, "Testing of Cooling Water System," as it relates to allowing operational functional testing of safety-related systems or components to ensure structural integrity and system leaktightness, operability, and adequate performance of active system components, as well as the capability of the integrated system to perform the required functions during normal, shutdown, and accident conditions

- GDC 61, as it relates to the following system design criteria for fuel storage and handling of radioactive materials:

  - capability for periodic testing of components important to safety

  - provisions for containment

  - provisions for decay heat removal

  - capability to prevent reduction in fuel storage coolant inventory under accident conditions in accordance with Regulatory Position C.6 of RG 1.13

  - capability and capacity to remove corrosion products, radioactive materials, and impurities from the pool water and reduce occupational exposures

- GDC 63, as it relates to monitoring systems provided to detect conditions that could result in the loss of decay heat removal capabilities, detect excessive radiation levels, and initiate appropriate safety actions

- Title 10, Section 20.1101(b), of the Code of Federal Regulations (10 CFR 20.1101(b)), as it relates to radiation doses being kept as low as is reasonably achievable (ALARA)

Compliance with the requirements of GDC 2 depends on adherence to the guidance of Positions C.1, C.2, C.6, and C.8 of RG 1.13, as well as Regulatory Position C.1 (safety-related portions of the system) and Regulatory Position C.2 (non-safety-related portions of the system) of RG 1.29. Compliance with the requirements of GDC 4 depends on adherence to the guidance of Regulatory Position C.2 of RG 1.13. Compliance with the requirements of GDC 44 depends on adherence to the recommendations of SRP Branch Technical Position (BTP) Auxiliary Systems Branch (ASB) 9-2, "Residual Decay Energy for Light Water Reactors for Long-Term Cooling," for calculating the heat loads, the assumptions set forth in Item 1.h of Subsection III of SRP Section 9.1.3, and the pool temperature limitations identified in Item 1.d of Subsection III of SRP Section 9.1.3. Compliance with the requirements of 10 CFR 20.1101(b) depends on adherence to the guidance of Positions C.2(f)(2) and C.2.f(3) of

RG 8.8, “Information Relevant to Ensuring that Occupational Radiation Exposures at Nuclear Power Stations Will Be As Low As Is Reasonably Achievable.”

In DCD Tier 2, Section 9.1.3.2, “System Description,” the applicant states that the SFP cooling system is a non-safety-related system. The water in the pool performs the safety-related function of cooling and shielding the fuel in the SFP. DCD Tier 2, Figure 9.1-5, provides a simplified sketch of the system.

The applicant states that the SFP cooling system consists of two mechanical trains of equipment. Each train consists of one SFP pump, one SFP heat exchanger, one SFP demineralizer, and one SFP filter. The two trains of equipment share common suction and discharge headers. In addition, the SFP cooling system comprises piping, valves, and instrumentation necessary for system operation. Either train of equipment can perform any of the functions required of the SFP cooling system independently of the other train. One train is continuously cooling and purifying the SFP, while the other train is available for water transfers or in-containment refueling water storage tank (IRWST) purification or is aligned as a backup to the operating train of equipment.

Both trains are designed to process SFP water. Each pump takes suction from the common suction header and discharges directly to its respective heat exchanger. The outlet piping branches into parallel lines. The purification branch is designed to process approximately 20 percent of the cooling flow, while the bypass branch passes the remaining. Each purification branch is routed directly to a SFP demineralizer. The outlet of the demineralizer is routed to a SFP filter. The outlet of the filter then connects to the bypass branch, which forms a common line that connects to the discharge header.

The SFP cooling system suction header connects to the SFP at two locations. The main suction line connects to the SFP at an elevation 0.6 m (2 ft) below the normal water level of the pool. Two skimmer connections take suction from the water surface of the SFP. This suction arrangement prevents the SFP from inadvertently being drained below a level that would prevent the water in the SFP from performing its safety functions. This arrangement also eliminates the need for a separate skimmer circuit arrangement.

The SFP pump suction header connects to the IRWST and the refueling cavity. This enables purification of the IRWST or the refueling cavity and allows for the transfer of water between the IRWST and the refueling cavity. The SFP pump suction header also connects to the fuel transfer canal and the cask loading pit. The purpose of these connections is primarily to transfer water from the fuel transfer canal to the cask loading pit. Water that is normally stored in the fuel transfer canal can be sent to the cask loading pit and from the cask loading pit back to the transfer canal.

The SFP is initially filled with water having a boron concentration of approximately 2500 parts per million (ppm). For makeup purposes, including replacement of evaporative losses, the demineralized water transfer and storage system provides demineralized water to the SFP. Boron may be added to the SFP from the chemical and volume control system (CVS).

A gate may be used to separate the SFP water from the water in the transfer canal. The gate enables drainage of the transfer canal to permit maintenance of the fuel transfer equipment.

The staff reviewed the SFPCPS for compliance with the requirements of GDC 2, 4, 5, 44, 45, 46, 61, and 63 and 10 CFR 20.1101(b), as referenced in SRP Section 9.1.3. The staff finds that the AP1000 SFPCPS is not a safety-related system and is not required to operate following events such as earthquakes, fires, passive failures, or multiple active failures. The SFPCPS has the safety-related functions of providing containment isolation and providing safety-related connections for temporary emergency makeup to the SFP for cooling. Seismically qualified safety-related makeup connections from the passive containment cooling system (PCS) can provide SFP makeup for a long-term station blackout. These connections are in an area of the auxiliary building that operating personnel can access without being exposed to excessive levels of radiation or adverse environmental conditions during boiling of the pool.

In the design of the SFP, water is maintained above the spent fuel assemblies for at least 7 days following a loss of the SFP cooling system. In accordance with the design, the minimum water level to achieve sufficient cooling is the subcooled, collapsed level (without vapor voids) required to cover the top of the fuel assemblies. Therefore, the applicable portion of the GDC 2 requirements is that the structure housing the system must be able to withstand the effects of natural phenomena, such as earthquakes, tornados, and hurricanes. Because the SFP is located in a seismic Category I building in the fuel-handling area, the staff has determined that the SFPCPS is protected from natural phenomena and complies with Regulatory Positions C.1, C.2, C.6, and C.8 of RG 1.13 and Regulatory Positions C.1 and C.2 of RG 1.29. Thus, the staff concludes that the SFPCPS complies with the requirements of GDC 2. The SFPCPS is also in compliance with the applicable portions of the following requirements:

- GDC 4, as it relates to the ability of the structure housing the system to withstand the effects of external missiles

  The SFP is located in a seismic Category I building. Therefore, the SFPCPS is protected from external missiles. Thus, the staff concludes that the SFPCPS complies with Regulatory Position C.4 of RG 1.13 and thus the requirements of GDC 4.

- GDC 5, as it relates to whether shared SSCs important to safety are capable of performing required safety functions

  In that the AP1000 is a single-unit design, and a COL applicant must comply with GDC 5 for a multiple-unit site, the staff finds that the SFPCPS complies with the requirements of GDC 5.

- GDC 44, as it relates to the system’s ability to transfer heat loads from safety-related SSCs to a heat sink under both normal operating and accident conditions

  There are no safety-related SSCs involved in the SFP system under normal operating conditions; however, during accident conditions, the SFP is designed to cool by boiling and transferring the heat to the atmosphere. Therefore, the SFPCPS meets the intent of BTP ASB 9-2, thereby meeting the intent of GDC 44.

- GDC 45, as it relates to allowing periodic inspection of safety-related components and equipment

The spent pool cooling system is not a safety-related system; however, DCD Tier 2, Section 9.1.3.6.2, states that periodic visual inspections and preventive maintenance will be performed. Therefore, the SFPCPS meets the intent of GDC 45.

- GDC 46, as it relates to the capability of the system to perform required functions during normal, shutdown, and accident situations

  As discussed above, the SFPCPS meets the required functions of providing containment isolation and providing safety-related connections for temporary emergency makeup for SFP cooling. Therefore, the SFPCPS meets the intent of GDC 46.

- GDC 61, as it relates to provisions for decay heat removal; the capability to prevent reduction in fuel storage coolant inventory under accident conditions; and the capability and capacity to remove fission products, radioactive materials, and impurities from the pool water and reduce occupational exposures

  Under accident conditions, the system is designed to provide makeup water for 7 days. In addition, the staff finds the purification system acceptable to remove fission products and radioactive materials from the pool water, thereby reducing occupational exposures. Thus, the staff concludes that the SFPCPS complies with the requirements of GDC 61.

- GDC 63, as it relates to monitoring systems provided to detect conditions that could result in the loss of decay heat removal capabilities, detect excessive radiation levels, and initiate appropriate safety actions

  The AP1000 design provides acceptable instrumentation to measure temperature, pressure, flow, and level in the SFP. The design also limits exposure rates at the surface of the SFP to less than 25 Microsieverts per hour (2.5 millirem per hour (mrem/hr)). This corresponds to an activity level in the water of approximately 0.005 microcurie per gram for the dominant gamma-emitting isotopes at the time of refueling. The SFP cooling system flow rate for one train shall exceed the rate necessary to provide two water volume changes in 24 hours for the SFP water. Therefore, the staff concludes that the SFPCPS complies with the requirements of GDC 63.

- The requirements of 10 CFR 20.110(b), as they relate to the design of the fuel pool cooling system purification capability to minimize the occupational radiation exposure and thereby keeping radiation doses ALARA

  The staff finds that the SFP cooling system provides a purification and filtration system design that will minimize the occupational radiation exposure, thereby keeping radiation doses ALARA, and meeting the intent of RG 8.8. Accordingly, the staff concludes that the SFPCPS complies with the requirements of 10 CFR 20.110(b).

On the basis of the preceding findings, the staff concludes that the information provided by the applicant regarding the design of the SFPCPS is acceptable.

9.1.4 Light-Load Handling System (Related to Refueling)

The staff reviewed the light-load handling system (LLHS) in accordance with SRP Section 9.1.4, “Light Load Handling System.” Staff acceptance of the design of the system is contingent on compliance with the following requirements:

- GDC 2, as it relates to the ability of SSCs to withstand the effects of earthquakes

- GDC 5, as it relates to whether shared SSCs important to safety are capable of performing required safety functions

- GDC 61, as it relates to a radioactivity release resulting from fuel damage and the avoidance of excessive personnel radiation exposure

- GDC 62, as it relates to criticality accidents

In accordance with SRP Section 9.1.4, compliance with the requirements of GDC 2 depends on adherence to the guidance of Regulatory Positions C.1 and C.6 of RG 1.13, as well as Positions C.1 and C.2 of RG 1.29. In accordance with SRP Section 9.1.4, compliance with the requirements of GDC 61 depends on adherence to the guidance of Regulatory Position C.3 of RG 1.13, as well as ANS 57.1/ANSI-N208. In accordance with SRP Section 9.1.4, compliance with the requirements of GDC 62 depends on adherence to the guidance of Regulatory Position C.3 of RG 1.13, as well as ANS 57.1/ANSI-N208.

In DCD Tier 2, Section 9.1.4.2, the applicant states that the LLHS consists of the equipment and structures needed for the refueling operation. This equipment includes fuel assemblies, core component and reactor component hoisting equipment, handling equipment, and a dual-basket fuel transfer system. The following structures are associated with the fuel-handling equipment:

- refueling cavity
- transfer canal
- fuel transfer tube
- SFP
- cask loading area
- new fuel storage area
- new fuel receiving and inspection area

The fuel-handling equipment is designed to handle the spent fuel assemblies underwater from the time they leave the reactor vessel until they are placed in a container for shipment from the site. As described below, underwater transfer of spent fuel assemblies provides an effective and transparent radiation shield, as well as a reliable cooling medium for removal of decay heat. The boric acid concentration in the water is sufficient to preclude criticality.

The associated fuel-handling structures may be generally divided into two areas:

- the refueling cavity, which is flooded only during plant shutdown for refueling
- the SFP and transfer canal, which are kept full of water

The fuel transfer tube, which is fitted with a quick-opening hatch on the canal end and a valve on the fuel storage area end, connects the refueling cavity and fuel storage area. The hatch is in place, except during refueling, to provide containment integrity. An underwater transfer car carries fuel through the tube.

The refueling machine moves fuel between the reactor vessel and the fuel transfer system. The fuel transfer system moves up to two fuel assemblies at a time between the containment building and the auxiliary building fuel-handling area. After a fuel assembly is placed in the fuel container, the lifting arm pivots the fuel assembly to the horizontal position for passage through the seismic Category I fuel transfer tube, in accordance with Regulatory Positions C.1 and C.6 of RG 1.13 and Regulatory Positions C.1 and C.2 of RG 1.29. After the transfer car transports the fuel assembly through the transfer tube, the lifting arm at that end of the tube pivots the assembly to a vertical position so that the assembly can be lifted out of the fuel container.

In the fuel-handling area, the seismic Category I fuel-handling machine moves the fuel assemblies, in accordance with Regulatory Positions C.1 and C.6 of RG 1.13 and Regulatory Positions C.1 and C.2 of RG 1.29. Initially, a short tool is used to handle new fuel assemblies, but the new fuel elevator must be used to lower the assembly to a depth at which the fuel-handling machine can place the new fuel assemblies into or out of the spent fuel storage racks.

The seismic Category II new fuel jib crane removes new fuel assemblies received for refueling one at a time from the shipping container and moves them into the new fuel assembly inspection area.

DCD Tier 2, Section 9.1.4.1.1, "Safety Design Basis," states that in the event of an SSE, handling equipment cannot fail in such a manner as to prevent the required function of seismic Category I equipment. On the basis of the preceding discussion, the staff concludes that the LLHS complies with the requirements of GDC 2.

The transfer car controls for the fuel transfer system are located in the fuel-handling area. Therefore, conditions in the containment are not visible to the operator. The transfer car permissive switch allows the fuel transfer system containment operator to exercise some control over car movement, if conditions visible to the operator warrant such control.

In accordance with Regulatory Position C.3 of RG 1.13 and ANS 57.1/ANSI-N208, an interlock on the fuel transfer system prevents the upender from being moved from the horizontal to the vertical position if the transfer car has not reached the end of its travel. An interlock on the transfer tube valve permits transfer car operation only when the transfer tube valve position switch indicates that the valve is fully open.

The fuel transfer system is also interlocked with the refueling machine. Whenever the transfer car is located in the refueling cavity, the fuel transfer system cannot be operated unless the refueling machine mast is in the fully retracted position, the refueling machine is over the core, or the gripper is released and inside the core.

On the SFP side, the fuel transfer system is interlocked with the fuel-handling machine. The fuel transfer system cannot be operated until the fuel-handling machine is moved away from the fuel transfer system area.

Fuel-handling tools and equipment handled over an open reactor vessel are designed to prevent inadvertent decoupling from machine hooks. In addition, lifting rigs are pinned to the machine hook, and hook supporting tools have safety latches. Tools required for handling internal reactor components are designed with the following fail-safe features that prevent disengagement of the component in the event of operating mechanism malfunction:

- The air cylinders actuating the gripper mechanism are equipped with backup springs that close the gripper in the event of loss of air to the cylinder. Air-operated valves are equipped with safety locking rings to prevent inadvertent actuation.

- When the fingers are latched, the actuating handle is positively locked, preventing inadvertent actuation. The tool is preoperationally tested at 125 percent of the weight of one fuel assembly.

During spent fuel transfer, the gamma dose rate at the surface of the water is 20 mrem/hr or less, achieved by maintaining a minimum of 3 m (10 ft) of water above the top of the active fuel height during handling operations. The three fuel-handling devices used to lift spent fuel assemblies are the refueling machine, the fuel-handling machine, and the spent fuel-handling tool. Both the refueling machine and fuel-handling machine contain positive stops that prevent the fuel assembly from being raised above a safe shielding height.

DCD Tier 2, Section 9.1.4.1.1, states that the fuel-handling devices have provisions to avoid dropping or jamming fuel assemblies during transfer operation and that the handling equipment has provisions to avoid dropping fuel-handling devices during the fuel transfer operation. On the basis of the preceding discussion, the staff concludes that the LLHS meets the intent of GDC 61 and 62.

The staff finds that the LLHS for the AP1000 design complies with GDC 2, as it relates to the ability of SSCs to withstand the effects of an earthquake. The LLHS complies with GDC 5, as it relates to whether shared SSCs important to safety can perform their required safety functions, in accordance with DCD Tier 2, Section 3.1.1, which states, “The AP1000 is a single-unit plant. If more than one unit were built on the same site, none of the safety-related systems would be shared.” The LLHS also complies with the intent of GDC 61 and 62, as related to a radioactivity release resulting from fuel damage and the avoidance of excessive personnel radiation exposure, and criticality accidents, respectively.

9.1.5 Overhead Heavy-Load Handling Systems

The staff’s acceptance of the design of a heavy-load handling systems (HLHSs) is contingent on compliance with the following requirements:

- GDC 2, as it relates to the ability of SSCs to withstand the effects of natural phenomena such as earthquakes

- GDC 4, as it relates to the protection of safety-related equipment from the effects of internally-generated missiles (i.e., dropped loads)

- GDC 5, as it relates to whether shared SSCs important to safety are capable of performing their required safety functions

- GDC 61, as it relates to the safe handling and storage of fuel

Compliance with the requirements of GDC 2 depends on adherence to the guidance of Regulatory Positions C.1 and C.6 of RG 1.13, as well as Regulatory Positions C.1 and C.2 of RG 1.29. Compliance with the requirements of GDC 4 depends on adherence to the guidance of Regulatory Positions C.3 and C.5 of RG 1.13. Other guidelines used in the evaluation of this system include NUREG-0612, “Control of Heavy Loads at Nuclear Power Plants,” issued in July 1980.

For the AP1000 design, the applicant defines a heavy load to be one that weighs more than the combined weight (about 1406 kg (3100 lbs)) of a fuel assembly with a rod cluster control, and the associated handling device (consisting of the inner mast of the fuel-handling machine and the fuel-gripper assembly). This equipment is part of the mechanical handling system (MHS) and is located throughout the plant. An HLHS is generally classified as a non-safety-related, nonseismic system. The components of single-failure-proof systems necessary to prevent uncontrolled lowering of a critical load are classified as safety-related.

The containment polar crane, the equipment hatch hoist system, and the maintenance hatch hoist system are single-failure-proof systems. Classified as seismic Category I, they are designed to support a critical load during and after an SSE and thus are in compliance with Regulatory Positions C.1 and C.6 of RG 1.13 and Regulatory Positions C.1 and C.2 of RG 1.29. A critical load is a heavy load that, if dropped, could cause unacceptable damage to reactor fuel elements, or a loss of safe shutdown or decay heat removal capability. Therefore, the staff concludes that the HLHSs comply with the requirements of GDC 2.

For the AP1000 design, the plant arrangement and the design of HLHSs reflect on the following criteria:

- In accordance with Regulatory Positions C.3 and C.5 of RG 1.13, to the extent practicable, the system does not carry heavy loads over or near safety-related components, including irradiated fuel and safe-shutdown components. Safe load paths are designed for heavy load handling in safety-related areas.

- In accordance with the guidance of NUREG-0612:

  - The likelihood of a load drop is extremely small (that is, the handling system is single-failure proof), or the consequences of a postulated load drop are within acceptable limits.

  - Single-failure-proof systems can stop and hold a critical load following the credible failure of a single component.

  - Single-failure-proof systems can support a critical load during and after an SSE.

Except for the containment polar crane, the equipment hatch hoist system, and the maintenance hatch hoist system, the HLHSs are not single-failure proof. The DCD states that overhead cranes are designed according to American Society of Mechanical Engineers

(ASME) NOG-1, “Rules for Construction of Overhead and Gantry Cranes.” The design of other cranes and hoists handling heavy loads follows applicable ANSI standards.

In DCD Tier 2, Section 9.1.5.3, the applicant states that for the polar crane and the equipment and maintenance hatch hoist systems, the design provides redundancy for load-bearing components, such as hoisting ropes, sheaves, equalizer assembly, hooks, and holding brakes. These systems are designed to support a critical load during and after an SSE.

The spent fuel shipping cask storage pit is separate from the SFP. The spent fuel shipping cask crane cannot move over the SFP because the crane rails do not extend over the pool. Mechanical stops prevent the spent fuel shipping cask crane from going beyond the ends of the rails.

In DCD Tier 2, Section 9.1.5.3, the applicant also states that a heavy load analysis evaluates postulated load drops from HLHSs located in safety-related areas of the plant, specifically the nuclear island. The applicant further states that critical loads handled by the single-failure-proof containment polar crane, equipment hatch hoist, or maintenance hatch hoist do not require evaluations, because a load drop is unlikely. In accordance with NUREG-0612, the purpose of the heavy load analysis is to confirm that a postulated load drop does not cause unacceptable damage to reactor fuel elements or a loss of safe shutdown or decay heat removal capability. For these reasons, the staff concludes that the HLHSs comply with the requirements of GDC 61.

As described above, the staff concludes that the design of the AP1000 HLHSs comply with the requirements of GDC 2, as they relate to the ability of SSCs to withstand the effects of natural phenomena, such as earthquakes. The HLHSs also comply with GDC 4, as it relates to protection of safety-related equipment from the effects of internally-generated missiles, because in DCD Tier 2, Section 9.1.1.2.1, Item E, the applicant stated that the fuel-handling area does not contain any credible sources of internally-generated missiles. In that the AP1000 is a single-unit design, and a COL applicant must comply with GDC 5 for a multiple-unit site, the staff finds that the HLHSs comply with the requirements of GDC 5, relating to whether shared SSCs important to safety can perform their required safety functions. The design of the HLHSs is also in compliance with GDC 61, as it relates to the safe handling and storage of fuel.

9.1.6 Combined License Information Items

In DCD Tier 2, Section 9.1.6, “Combined License Information for Fuel Storage and Handling,” Westinghouse describes the following COL Action Items: (note that the NRC staff action item number is after each Westinghouse item)

The Combined License applicant is responsible for a confirmatory structural dynamic and stress analysis for the new fuel rack as described in DCD Tier 2, Section 9.1.1.2.1. This is COL Action Item 9.1.6-1.

The Combined License applicant is responsible for a confirmatory criticality analysis for the new fuel rack, as described in DCD Tier 2, Section 9.1.1.3. This analysis should address the degradation of integral neutron absorbing material in the new fuel pool storage racks as identified in GL 96-04, and assess the integral neutron absorbing material capability to maintain a 5-percent subcriticality margin. This is COL Action Item 9.1.6-2.

The Combined License applicant is responsible for a confirmatory structural dynamic and stress analysis for the spent fuel racks, as described in DCD Tier 2, Section 9.1.2.2.1. This includes reconciliation of loads imposed by the spent fuel racks on the spent fuel pool structure described in DCD Tier 2, Section 3.8.4. This is COL Action Item 9.1.6-3.

The Combined License applicant is responsible for a confirmatory criticality analysis for the spent fuel racks, as described in DCD Tier 2, Section 9.1.2.3. This analysis should address the degradation of integral neutron absorbing material in the spent fuel pool storage racks as identified in GL 96-04, and assess the integral neutron absorbing material capability to maintain a 5-percent subcriticality margin. This is COL Action Item 9.1.6-4.

The Combined License applicant is responsible for a program for inservice inspection of the light load handling system as specified in DCD Tier 2, Section 9.1.4.4 and the overhead heavy load handling system in accordance with ANSI B30.2, ANSI B30.9, ANSI N14.6, and ASME NOG-1 as specified in DCD Tier 2, Section 9.1.5.4. This is COL Action Item 9.1.6-5.

The Combined License applicant/holder is responsible to ensure an operation radiation monitor is mounted on any crane or fuel handling machine when it is handling fuel. This is COL Action Item 9.1.6-6.

9.2 <u>Water Systems</u>

The following sections describe the staff’s review of the AP1000 water systems:

- 9.2.1, “Service Water System”
- 9.2.2, “Component Cooling Water System”
- 9.2.3, “Demineralized Water Treatment System”
- 9.2.4, “Demineralized Water Transfer and Storage System”
- 9.2.5, “Potable Water System”
- 9.2.6, “Sanitary Drainage System”
- 9.2.7, “Central Chilled Water System”
- 9.2.8, “Turbine Building Closed Cooling System”
- 9.2.9, “Waste Water System”
- 9.2.10, “Hot Water Heating System”

Either single-unit or multiple-unit sites can use the AP1000 design. Nonetheless, in DCD Tier 2, Section 3.1.1, the applicant states that the AP1000 design is a single-unit plant, and if more than one unit is built on the same site, multiple units will not share the safety-related systems. Should a multiple-unit site be proposed, the COL applicant referencing the AP1000 design will be required to apply for the evaluation of the units’ compliance with the requirements of GDC 5, “Sharing of Structures, Systems, and Components,” with respect to the capability of shared SSCs to perform their required safety functions.

9.2.1 Service Water System

The staff reviewed the design of the service water system (SWS) in accordance with SRP Section 9.2.1, “Station Service Water System.” However, the SWS for the AP1000 differs from that of the traditional pressurized-water reactor (PWR) designs in that the AP1000 SWS is a completely non-safety-related system with no safety-related function. In traditional PWRs, portions of the SWS were required to perform safety-related functions. The AP1000 SWS is a non-safety-related system because the SWS removes heat only from the component cooling water system (CCS) which is not a safety-related system. Section 9.2.2 of this report contains the staff's evaluation of the CCS as non-safety-related. Therefore, the portions of SRP Section 9.2.1 that apply to safety-related systems do not apply to the AP1000 SWS. As for the non-safety-related SWS meeting the requirements of GDC 2, as they relate to structures and systems being capable of withstanding the effects of natural phenomena, acceptance depends on meeting the guidance of the portions of Regulatory Position C.2 of RG 1.29 regarding non-safety-related systems.

The SWS supplies cooling water to remove heat from the CCS heat exchangers which are located in the turbine building. The system consists of two 100-percent capacity cooling trains of components and piping for normal power operation. Each train includes one service water pump, one component cooling heat exchanger, one strainer, and one cooling tower cell. Because of cross-connections between the trains upstream and downstream of the heat exchangers, either service water pump can supply cooling water to either heat exchanger, and either heat exchanger can discharge to either cooling tower. The cooling tower, cooling tower fans, pumps, and applicable valves of the SWS are classified as AP1000 Class D, seismic Category NS (nonseismic). To provide reasonable assurance that the SWS is operable during anticipated events, the applicant included it in the AP1000 programs, "Investment Protection Short-Term Availability Controls" and "Design Reliability Assurance Program."

The investment protection short-term availability controls (IPSAC), as described in AP1000 DCD Tier 2, Section 16.3, "Investment Protection," define the following:

- equipment that should be operable
- operational modes when the equipment should be operable
- testing and inspections that should be used to demonstrate the equipment's operability
- operational modes that should be used for planned maintenance operations
- remedial actions that should be taken if the equipment is not operable

The Design Reliability Assurance Program (D-RAP), as described in AP1000 DCD Tier 2, Section 17.4, "Design Reliability Assurance Program," provides confidence that equipment remains available and reliable throughout plant life through the Maintenance Rule (10 CFR 50.65, "Requirements for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants").

The service water pumps are centrifugal pumps driven by electric motors. Each pump has a design flow rate of 34.1 m^3/min (9000 gpm). These pumps take suction from the service water pump basin through fixed screens to the pump suction piping. The service water pumps discharge through strainers to the CCS heat exchangers. The heated SWS water from the heat exchangers passes through the discharge piping to the mechanical draft cooling tower, where the system heat is rejected. The cool water, collected in the tower basin, provides the source for the suction of service water pumps.

The power supplies for the SWS pumps and associated active components are from independent and non-safety-related electrical buses. One of two onsite standby diesel generators (DGs) can supply each bus. In the event of loss of normal ac power, the SWS pumps and cooling tower fans, along with the associated motor-operated valves, are automatically loaded onto their associated diesel buses. The SWS, therefore, continues to provide cooling water to the required components during the loss of normal ac power events.

The SWS operates during startup, normal plant operation, normal plant cooldown, and refueling and is available following a LOOP event. Under normal plant operation, one of the two SWS trains removes the heat from one of the two CCS heat exchangers and discharges it to the cooling tower. The standby train automatically starts on combined low-flow and low-pressure values when the operating train fails. During accident conditions, the SWS remains in the same operating modes as for normal operations. Both SWS trains are used during plant startup, shutdown, and refueling.

A radiation monitor with a high alarm checks the service water blowdown flow for potentially radioactive leakage into the SWS from the CCS heat exchangers. Provisions for taking local fluid samples are also available. If radioactive fluid is detected in the SWS, the operator can isolate cooling tower blowdown flow by remote manual control.

With regard to sufficient net positive suction head (NPSH) available for SWS pumps and the potential for water hammer, in DCD Tier 2, Section 9.2.1.2.1, “General Description,” the applicant stated that temperatures in the system are moderate and that the pressure of the system is kept above saturation at all locations. The system pressure and temperature relation, and other design features of the system arrangement and control of valves, ensures that sufficient NPSH is available for SWS pumps and minimizes the potential for thermodynamic or transient water hammer.

The maximum ambient air wet bulb temperature specified in DCD Tier 2, Chapter 2, “Site Characteristics,” for site interface parameters is 26.67 °C (80 °F). This maximum wet bulb temperature applies to most U.S. plant sites. Actual site-specific data will dictate design parameters of the cooling tower. Specific site analysis to adjust cooling system capability should accommodate specific site conditions that exceed the 26.67 °C (80 °F) wet bulb temperature.

In DCD Tier 2, Section 9.2.1.1.1, the applicant states that failure of the SWS or its components will not affect the ability of any other safety-related systems to perform their intended safety functions. Postulated breaks in the SWS piping will not impact safety-related components because the SWS is not located in the vicinity of any safety-related equipment, and the water from the break will not reach any safety-related equipment. Therefore, the staff finds that the SWS complies with GDC 2 because it meets the guidance of Regulatory Position C.2 of RG 1.29 for ensuring that the non-safety-related SWS can withstand the effects of earthquakes without affecting safety-related systems.

As described above, the staff has reviewed the SWS in accordance with SRP Section 9.2.1. Because the AP1000 SWS is not safety-related, and its failure does not lead to the failure of any safety systems, the requirements of GDC 4, 44, 45, and 46 and the guidance of SRP Section 9.2.1, regarding safety-related systems, do not apply.

On the basis of the preceding review, the staff finds that the SWS design meets the applicable provisions described in SRP Section 9.2.1. Also, the SWS and its components are classified as

AP1000 Class D and included in the AP1000 IPSAC and D-RAP. Therefore, the staff finds the SWS acceptable.

9.2.2 Component Cooling Water System

The staff reviewed the design of the CCS in accordance with the guidance of SRP Section 9.2.2, “Reactor Auxiliary Cooling Water Systems.”

The CCS is a non-safety-related, closed-loop cooling system that transfers heat from various non-safety-related plant components to the SWS during normal plant operation. It also removes heat from various safety-related components (i.e., reactor cooling pumps, CVS letdown heat exchangers, and normal residual heat removal system (RNS) heat exchangers and pumps). However, none of these safety-related components requires cooling water to perform its safety-related functions. The safety-related functions of these components are limited to maintaining primary coolant system integrity and providing reactor coolant pump coastdown capability. The passive core cooling system (PXS) and PCS provide safety-related cooldown and decay heat removal functions.

The CCS provides a barrier to prevent the release of radioactivity from plant components that handle cooling radioactive fluid to the environment. The CCS also provides a barrier against leakage of service water into primary containment and reactor systems.

The CCS consists of two trains and one component cooling water (CCW) surge tank. Each train consists of one CCW pump and one CCW heat exchanger, as well as associated valves, piping, and instrumentation. The CCW surge tank, which accommodates thermal expansion and contraction, connects to a shared portion of the return header. The two trains of equipment take suction from a single return header. The discharge of each heat exchanger is routed directly to the common supply header. This single supply/return header distributes cooling water to the components. Loads inside containment are automatically isolated in response to a safety injection signal which trips the reactor coolant pumps. Individual components, except the reactor coolant pumps, can be isolated locally to permit maintenance, while supplying the remaining components with cooling water.

The two CCW pumps are horizontal, centrifugal pumps. Each pump has a design flow rate of 33.9 m^3/min (8960 gpm). The pumps are redundant for normal operation heat loads. The design-basis cooldown requires both pumps; however, an extended cooldown can be achieved with only one pump in operation. Each pump can be aligned to either heat exchanger. Cooling in the heat exchanger is provided by the SWS. The CCW system pressure is maintained at a higher pressure than the service water to prevent in-leakage from the service water into the system. Three motor-operated isolation valves and a check valve provide containment isolation for the supply and return CCS lines that penetrate the containment barrier. The motor-operated valves are normally open and are closed upon receipt of a safety injection signal.

The power supplies for the CCS pumps and associated active components are independent and are from non-safety-related electrical buses. In the event of loss of normal ac power, the CCS pumps are automatically loaded on the standby diesel. The CCS, therefore, continues to provide cooling water to the required components during the loss of normal ac power events.

The CCS provides cooling water to the safety-related components identified above during normal plant operation and normal reactor shutdown and cooldown. The PXS and PCS provide safety-related cooldown and decay heat removal functions following a loss-of-coolant accident (LOCA). Therefore, the CCS serves no safety-related function, except for containment isolation. Segments of the CCS piping that penetrate the containment and the associated containment isolation valves are safety-related and perform a safety-related containment isolation function. Therefore, these segments are designed to accommodate environmental and dynamic effects associated with pipe breaks, thereby satisfying the requirements of GDC 4. Section 3.6.1 of this report evaluates protection against the effects of pipe breaks, and Section 3.4.1 of this report evaluates protection against internal flooding.

DCD Tier 2, Table 3.2-3, classifies CCS pumps and valves (with the exception of containment isolation valves) as AP1000 Class D, seismic Category NS. In addition, the CCS pumps and valves are included in the AP1000 IPSAC and D-RAP. The containment penetration isolation valves are Safety Class B, as is the pipe between the isolation valves.

On the basis of its review, the staff agrees with the applicant that the CCS does not perform any safety-related function except for containment isolation. Therefore, the portions of SRP Section 9.2.2 that apply to safety-related systems do not apply to the AP1000 CCS.

In DCD Tier 2, Section 9.2.2.1.1, the applicant states that failure of the CCS or its components will not affect the ability of safety-related systems to perform their intended safety functions. This conforms to the guidance of Regulatory Position C.2 of RG 1.29. Therefore, the staff concludes that the CCS complies with the requirements of GDC 2.

GDC 44, 45, and 46 do not apply to the CCS because the CCS heat loads are not safety-related.

The operating temperature of the CCS components will normally be well below 93.3 °C (200 °F), and the pressure will be maintained above atmospheric. Because the CCS will normally operate at temperatures and pressures that prevent formation of steam bubbles, water hammer issues will be avoided.

On the basis of the preceding review, the staff finds that the CCS design meets the applicable provisions described in SRP Section 9.2.2. Also, the CCS is included in the AP1000 IPSAC and D-RAP. Therefore, the staff finds the CCS to be acceptable.

9.2.3 Demineralized Water Treatment System

The staff reviewed DCD Tier 2, Section 9.2.3, “Demineralized Water Treatment System,” in accordance with SRP Section 9.2.3, “Demineralized Water Makeup System.” The demineralized water treatment system (DTS) is acceptable if the system is capable of providing the required supply of reactor coolant purity water to the demineralized water transfer and storage system (DWS). The DTS does not perform any safety-related function or accident mitigation, and its failure would not reduce the safety of the plant.

9.2.3.1 Summary of Technical Information

The AP1000 DTS receives water from the raw water system (RWS), processes this water to remove ionic impurities, and provides demineralized water to the DWS.

This system consists of the following major components:

- two reverse osmosis (RO) feed pumps
- two 100-percent RO units running in series
- one electrodeionization (EDI) unit for secondary demineralization

DCD Tier 2, Table 9.2.3-1, "Guidelines for Demineralized Water (Measured at the Outlet of the Demineralized Water Treatment System)," provides the system functional specifications for the DTS.

9.2.3.2 Staff Evaluation

The staff evaluated the design and operational requirements of the DTS and concluded that it includes all components associated with the system from the source of raw water to a discharge to the DWS. In addition, the staff reviewed the system functional specifications given in Table 9.2.3-1 to provide the appropriate reactor water coolant purity during all conditions of plant operation. However, high concentrations of halogens and sulfates in the system can accelerate the corrosion of components in the DTS. Therefore, by letter dated September 24, 2002, the staff sent request for additional information (RAI) 281.002 asking the applicant to provide the maximum allowable concentrations of halogens and sulfates in the system. By letter dated October 18, 2002, the applicant responded that the range of halogens and sulfates in this system is shown in Table 9.2.3-1, with the maximum value of 1 part per billion (ppb) for chloride and for sulfate.

The staff concluded that these maximum values for chloride and sulfate are appropriate because these values ensure adequate reactor coolant purity during all conditions of plant operation to keep the levels of corrosion low.

9.2.3.3 Conclusions

The design of the DTS includes the components and piping needed to collect and treat raw water and supply it to the DWS. The staff's review finds that the applicant's proposed design criteria and design bases for the DTS are sufficient to supply adequate reactor coolant purity water during all conditions of plant operation.

9.2.4 Demineralized Water Transfer and Storage System

The staff reviewed the DWS in accordance with the guidance of SRP Section 9.2.3. Specifically, the staff reviewed the system to ensure its capability to provide the required supply of reactor coolant pure makeup water to all systems. Acceptability of the DWS depends on its meeting the guidance of Regulatory Position C.2 of RG 1.29 for non-safety-related systems, the failure of which could affect the functioning of any safety-related system. Conformance with the acceptance criteria of the SRP forms the basis for concluding that the DWS satisfies the applicable requirements of GDC 2, as it relates to the system being capable of withstanding the effects of earthquakes.

The DWS is a non-safety-related system that supplies demineralized water (through the demineralized water storage tank) to fill the condensate storage tank and to the plant systems that demand a demineralized water supply. The DWS primarily consists of a 379-m^3 (100,000-gallon) capacity demineralized water storage tank, a 1,835-m^3 (485,000-gallon) capacity condensate storage tank, two motor-driven demineralized water transfer pumps, and two catalytic oxygen reduction units.

The demineralized water storage tank, which receives water from the DTS, supplies demineralized water to the makeup pumps of the CVS during startup. A low-level alarm on the tank signals the plant operator to isolate demands on the tank, other than the CVS supply. The condensate storage tank serves as a reservoir to supply or receive condensate as required by the condenser hotwell level control system. In the event of loss of main feedwater when the deaerator storage tank is not available, the condensate storage tank will serve as a backup water supply for the startup feedwater pumps. The condensate storage tank will provide sufficient water to the startup feedwater system to permit 8 hours of hot standby operation. Adequate isolation is provided at all makeup demineralized water connections to safety-related systems.

Two catalytic oxygen reduction units degasify the stored demineralized water. One unit is for the demineralized water distribution system, and the other unit is at the condensate storage tank. A check valve, in conjunction with a block valve, prevents backflow of fluids from systems that interface with the DWS. The applicant stated that the condensate storage tank normally contains no significant radioactive contaminants.

The DWS, with the exception of the containment isolation valves, is classified as AP1000 Class D, seismic Category NS. The containment penetration isolation valves are Safety Class B, as is the pipe between the isolation valves.

The system has no safety-related function other than containment isolation, and its failure does not affect the ability of safety-related systems to perform their intended safety functions. Therefore, the design conforms to the guidelines of Regulatory Position C.2 of RG 1.29. Regulatory Position C.1 of RG 1.29 does not apply to the DWS because the system performs no safety-related function.

Based on its review, the staff concludes that the DWS has the capability to provide an adequate supply of reactor coolant pure makeup water to all plant systems during all modes of plant operation. The design of the system complies with Regulatory Position C.2 of RG 1.29 concerning seismic classification and satisfies the applicable requirements of GDC 2 with respect to the need for protection against natural phenomena. Therefore, the staff concludes that the DWS meets the guidance of SRP Section 9.2.3 and, therefore, is acceptable.

9.2.5 Potable Water System

The staff reviewed the potable water system (PWS) in accordance with SRP Section 9.2.4, “Potable and Sanitary Water Systems.” Conformance with the acceptance criteria of the SRP forms the basis for concluding that the PWS satisfies GDC 60, “Control of Releases of

Radioactive Materials to the Environment," as it relates to design provisions for controlling the release of water containing radioactive material and preventing contamination of the potable water.

The PWS is a non-safety-related system that is designed to provide clean water from the raw water system for domestic use and human consumption. The system consists of a carbon steel tank with a capacity less than 37.85 m^3 (10,000 gallons), two motor-driven potable water pumps, a system jockey pump, a distribution header around the power block, hot water storage heaters, and necessary interconnecting piping and valves.

The potable water is treated to prevent harmful physiological effects, and its bacteriological and chemical quality conforms to the requirements of the Environmental Protection Agency (EPA) "National Primary Drinking Water Standards" (40 CFR Part 141). Upstream of the potable water storage tank, the turbine island chemical feed system disinfects the raw water supply to the tank. The PWS distribution complies with 29 CFR 1910, "Occupational Safety and Health Standards, Part 141."

In the DCD, the applicant states that no interconnections exist between the PWS and any potentially radioactive system or any system using water for purposes other than domestic water service. To prevent contamination of the PWS from other systems supplied by the RWS, the design of the common supply from the onsite RWS will use either an air gap or reduced-pressure-zone type backflow prevention device. Branches of the PWS supplying plumbing fixtures located in areas of potential radiological hazard where access is restricted are equipped with the reduced-pressure-zone-type backflow prevention devices. Therefore, the design of the PWS satisfies GDC 60, with respect to preventing contamination by the radioactive waste drain system.

On the basis of its review, the staff concludes that the design of the PWS, as described above, satisfies GDC 60, with respect to preventing contamination by radioactive water. Therefore, the staff concludes that the PWS meets the guidance of SRP Section 9.2.4 and, therefore, is acceptable.

9.2.6 Sanitary Drainage System

The staff reviewed the sanitary drainage system (SDS) in accordance with SRP Section 9.2.4. Conformance with the acceptance criteria of the SRP forms the basis for concluding that the SDS satisfies GDC 60, as it relates to design provisions provided control the release of radioactive materials to the environment.

The SDS is a non-safety-related system that collects sanitary wastes from plant restrooms and locker room facilities in the turbine building, auxiliary building, and annex building for treatment, dilution, and discharge. The system is designed to accommodate 0.1 m^3 (25 gallons) per person per day, for up to 500 persons during a 24-hour period. Testing and inspection of the system will be in accordance with the Uniform Plumbing Code Section 318, issued in 2000. The SDS components, such as branch lines, lift stations, and waste treatment plant, are site-specific and outside the scope of the AP1000 design.

In the DCD, the applicant states that the SDS does not serve the facilities in radiologically controlled areas and has no connection to the systems having the potential for containing radioactive material. Therefore, the design of the SDS satisfies GDC 60, with respect to preventing contamination by the radioactive waste drain system.

Based on its review, the staff concludes that the design of the SDS satisfies GDC 60, with respect to control of the release of water containing radioactive material. Therefore, the staff concludes that the SDS follows the guidance of SRP Section 9.2.4 and, therefore, is acceptable.

9.2.7 Central Chilled Water System

The staff reviewed the central chilled water system (VWS) in accordance with SRP Section 9.2.2. Conformance with the acceptance criteria of the SRP forms the basis for concluding that the central chilled water system satisfies GDC 2, 44, 45, and 46.

The VWS is a non-safety-related system that provides chilled water to the cooling coils of the supply air handling units and unit coolers of the following plant heating, ventilation, and air conditioning (HVAC) systems during normal modes of plant operation:

- radiologically controlled area ventilation system
- containment recirculation cooling system
- containment air filtration system
- health physics/control access area HVAC system
- radwaste building ventilation system
- Annex I and auxiliary building nonradioactive ventilation system

The VWS also supplies chilled water to the components of the liquid radwaste system, gaseous radwaste system, containment leak-rate-test system components, secondary sampling system, portable and mobile radwaste system, and electrical switchgear room and personal work area air handling units (AHUs) of the turbine building ventilation system.

The plant HVAC systems require chilled water as a cooling medium to satisfy the ambient temperature requirements for the plant. The CCS supplies the cooling water to the chiller condensers. The VWS is divided into two closed-loop subsystems (i.e., the high-capacity subsystem and the low-capacity subsystem).

The high-capacity subsystem, located in the turbine building, is the primary system to provide chilled water to the major HVAC systems listed above and to other plant equipment requiring chilled water cooling. The high-capacity subsystem consists of two 100-percent capacity chilled water pumps, two 100-percent capacity water-cooled chillers, a chemical feed tank, an expansion tank, and associated valves, piping, and instrumentation.

The high-capacity subsystem is arranged in two parallel trains with common supply and return headers. Each train includes one pump and one chiller. A cross-connection at the discharge of each pump allows for either pump to feed either chiller. During normal operation of the subsystem, one pump/chiller train provides chilled water to plant components at a normal temperature of 4.4 °C (40 °F). The standby train would be started manually if the operating train fails. The design cooling capacity of the high-capacity subsystem is founded on the ambient design temperature of 38 °C (100 °F) dry bulb and 29 °C (77 °F) coincident wet bulb maximum and -23 °C (-10 °F) minimum.

The low-capacity subsystem, located in the auxiliary building, provides chilled water to the HVAC systems in the main control room (MCR), the technical support center (TSC), and the Class 1E electrical equipment room. The low-capacity subsystem consists of two 100-percent capacity chilled water loops, each with a chilled water pump, an air-cooled chiller, an expansion tank, and associated valves, piping, and instrumentation.

This subsystem is arranged in two independent trains with separate supply and return headers. This subsystem configuration provides 100-percent redundancy during normal plant operation and during a LOOP. During normal operation of the subsystem, one pump/chiller train is required to supply chilled water to the components of the nuclear island nonradioactive ventilation system and the radiologically controlled area ventilation system at a normal temperature of 4.4 °C (40 °F). If one train is inoperable, the standby train can be manually aligned to supply chilled water to these components. The design cooling capacity for the low-capacity subsystem is founded on the ambient design temperatures of 46 °C (115 °F) dry bulb and 26.7 °C (80 °F) coincident wet bulb maximum.

The VWS, with the exception of the containment isolation valves, is classified as AP1000 Class D, seismic Category NS. The containment penetration isolation valves are Safety Class B, as is the pipe between the isolation valves.

The VWS has no safety-related function other than containment isolation, and its failure does not affect the ability of safety-related systems to perform their intended safety functions. Therefore, the design conforms to the guidelines of Regulatory Position C.2 of RG 1.29. Regulatory Position C.1 of RG 1.29 does not apply to the VWS because the system performs no safety-related function.

The VWS is not required to achieve safe shutdown or to mitigate any postulated accidents and serves no safety-related function, except for the portion of the system lines routed into the containment that require containment isolation. The high-capacity subsystem supply and return lines that penetrate the containment have two air-operated containment isolation valves. These valves automatically close upon receipt of a containment isolation signal. A bypass mode, with indication in the control room, is also provided to restore containment recirculation system cooling during containment isolation.

Because the VWS has no safety-related function, other than containment isolation, and a failure of the system will not affect the operation of safety-related equipment, the requirements of GDC 44, as related to the capability to transfer heat loads from safety-related systems, GDC 45, as related to inservice inspection of safety-related components and equipment, and GDC 46, as related to operational functional testing of safety-related systems or components, are not applicable.

On the basis of its review, the staff concludes that the safety-related portions of the system (the containment penetrations and the isolation valves) comply with Regulatory Position C.1 of RG 1.29, as they are designed in accordance with containment isolation provisions. Because the system serves no safety-related function and its failure as a result of an SSE would not reduce the functioning of any safety-related plant features, the non-safety-related portion of the system complies with Regulatory Position C.2 of RG 1.29. Therefore, the staff concludes that the design of the VWS meets the guidance of SRP Section 9.2.2 and, therefore, is acceptable.

9.2.8 Turbine Building Closed-Cooling System

The staff reviewed the design of the turbine building closed-cooling system (TCS) in accordance with applicable provisions of SRP Section 9.2.2. With respect to GDC 2, as related to structures and systems being capable of withstanding the effects of earthquakes, acceptance is based on meeting the guidance of Regulatory Position C.2 of RG 1.29 for non-safety-related portions of the system. Because the TCS is not safety-related, the requirements of GDC 4, 44, 45, and 46, as reflected in the guidance of SRP Section 9.2.2 do not apply.

The TCS is a closed-loop cooling water system that provides chemically treated, demineralized water for the removal of heat from non-safety-related heat exchangers in the turbine building and rejects the heat to the circulating water system (CWS). The TCS, which has no safety-related function and is classified as AP1000 Class D, seismic Category NS, consists of two 100-percent capacity pumps, three 50-percent capacity heat exchangers, a surge tank, a chemical addition tank, and associated piping, valves, and instrumentation and controls (I&C).

The TCS complies with GDC 2 by adhering to the guidance of Regulatory Position C.2 of RG 1.29 for ensuring that failures of the TCS during seismic events will not affect the performance of any safety-related systems or components. TCS piping and components are located entirely within the turbine building. No safety-related equipment is located in the turbine building. Therefore, the failure of the TCS (including the effects of jet impingement and flooding) cannot lead to the failure of any safety-related SSCs.

Because the TCS is not safety-related and its failure cannot lead to the failure of any safety systems, the TCS meets the requirements of GDC 2 because it conforms to Regulatory Position C.2 of RG 1.29, as described above. Therefore, the staff concludes that the design of the TCS meets the guidance of SRP Section 9.2.2 and, therefore, is acceptable.

9.2.9 Waste Water System

The staff reviewed the waste water system (WWS) in accordance with SRP Section 9.3.3, “Equipment and Floor Drainage System.” Conformance with the acceptance criteria of the SRP forms the basis for concluding that the WWS satisfies the requirements of GDC 2, 4, and 60.

The WWS is a non-safety-related system that collects and processes the waste water from the equipment and floor drains in the nonradioactive building areas during plant operation and outages. Wastes from the turbine building floor and equipment drains are collected in the two turbine building drain tanks for temporary storage. Drainage from the DG building sumps, the auxiliary building nonradioactive sump, and the annex building sump is also collected in the turbine building sumps. The waste water from either of the two drain tanks is then pumped to an oil separator for removal of oily waste. The oil separator has a small reservoir for storage of the separated oily waste which flows by gravity to a waste oil storage tank. The waste oil storage tank provides temporary storage before trucks remove the waste for offsite disposal. The waste water from the oil separator flows by gravity to a waste water retention basin, if required, for settling of suspended solids and treatment before discharge. The effluent in the retention basin is pumped to either the cooling tower basin or to plant outfall, depending on the quality of the water in the waste water retention basin.

If radioactivity is present in the drain tanks, a manual three-way valve allows for the waste water to be diverted from the drain tanks to the liquid radwaste system (WLS) for processing and disposal. A radiation monitor installed on the common discharge piping of the drain tank pumps can detect and isolate the contaminated waste water. The radiation monitor will alarm upon detecting radioactivity in the waste water and trip the drain tank pumps and the waste water retention basin pumps. The applicant states in the DCD that the design includes provisions for sampling the drain tanks for radioactive contamination. Therefore, the staff concludes that the design of the WWS satisfies GDC 60, with respect to control of the release of water from the WWS containing radioactive material.

In DCD Tier 2, Section 9.2.9.5, the applicant indicates that level controls for the building drain tanks and the waste water retention basin will prevent overflow of these waste water collection points. High-water-level alarms will alert the operator to take action. Section 3.4.1.2, “Internal Flooding,” of this report discusses the effects of flooding resulting from system pipe breaks or component failures in the nonradiologically controlled areas (NRCAs). The WWS pipe breaks or component failures are not the dominant sources of internal flood in the NRCAs. In Section 3.4.1.2 of this report, the staff concludes that the applicant properly identified safety-related equipment and flood hazards in the NRCAs and provided adequate means of protecting safety-related equipment from the identified flood hazards in the NRCAs. Therefore, the staff concludes that the design of the WWS complies with GDC 4, with respect to flood protection.

The staff also finds that the WWS design complies with the requirements of GDC 2, as related to the ability to withstand the effects of earthquakes. Compliance with GDC 2 is based on meeting the guidance of Regulatory Positions C.1 and C.2 of RG 1.29 concerning seismic classification. The WWS need not comply with Regulatory Position C.1 because the system is not safety-related. Instead, the WWS complies with the guidelines of Regulatory Position C.2 of RG 1.29 because failure of the system during an SSE will not reduce the function of any safety-related plant features.

Based on its review, the staff concludes that the WWS meets the NRC regulations set forth in the following review criteria:

- GDC 2, with respect to protecting the system against natural phenomena
- GDC 4, with respect to preventing flooding that could result in adverse effects on safety-related systems
- GDC 60, with respect to preventing the inadvertent transfer of contaminated fluids to the noncontaminated drainage system for disposal

Therefore, the design of the WWS meets the guidance of SRP Section 9.3.3 and, therefore, is acceptable.

9.2.10 Hot Water Heating System

The hot water heating system (VYS) supplies heated water to selected non-safety AHUs and unit heaters in the plant during cold weather operation and to the containment recirculation fan coil units during plant outages in cold weather. During a loss of normal ac power, onsite DGs will power the system. The VYS has no safety-related function and, therefore, no nuclear safety design basis. The VYS and its associated equipment are classified as AP1000 Class D, seismic Category NS. No GDC or SRP guidelines are directly applicable to the review of the VYS; therefore, the staff based its review of the VYS on relevant regulatory guidance and industry standards.

The VYS is a closed-loop system consisting of a heat transfer package (including two 50-percent capacity heat exchangers, two 50-percent capacity system pumps, a surge tank, and a chemical feed tank) and a distribution system to the various HVAC systems and unit heaters. The VYS is manually actuated and may operate when the site ambient temperature is 23 °C (73 °F) or below. The system uses a steam source from the high-pressure turbine cross-under piping to heat water by transferring the heat energy through the heat exchangers. During a plant outage, the auxiliary steam taken from the auxiliary boiler heats the water. The heated water is pumped to the hot water coils of the various HVAC systems and unit heaters. Condensate from the heat exchanger is level controlled and drained to the main condenser or auxiliary boiler feedwater system. The surge tank maintains the minimum system pressure above the saturation conditions at the pump suction. The chemical feed tank has the capability to provide chemical mixing in the system for corrosion control. The DWS supplies the makeup water for the VYS.

Based on its review and because the VYS is a non-safety-related system, has no safety-related function, and interfaces with only non-safety-related systems, the staff concludes that the requirements of GDC 5, 44, 45, and 46, and Appendix B to 10 CFR Part 50 do not apply to the VYS.

The VYS is a high-energy system. The VYS and VWS share piping inside the containment. During normal plant operation, the VYS is isolated from the VWS and containment. The applicant stated that the VYS piping is generally excluded from safety-related plant areas outside the containment. Piping of this system routed in the safety-related areas is 2.54 cm (1 in.) and smaller and is not evaluated for pipe ruptures.

Section 3.6 of this report addresses the staff’s evaluation of the protection against the dynamic effects associated with the postulated rupture of piping.

Section 3.4.1 of this report discusses the staff’s evaluation of the effects of flooding caused by postulated rupture of piping on the safe-shutdown capability of the plant.

On the basis of its review, the staff concludes the following:

- The VYS meets the requirements of GDC 2 because it serves no safety-related function and complies with Regulatory Position C.2 of RG 1.29 because it interfaces with only non-safety-related systems and its failure will not affect the functions of the safety-related systems. Regulatory Position C.1 of RG 1.29 is not applicable to the VYS because the system is not safety-related.

- The VYS, as designed to industrial standards as a nonseismic category and classified as AP1000 Class D, is acceptable because it is not a safety-related system.

Therefore, the staff concludes that the design of the VYS is acceptable.

9.3 Process Auxiliaries

The following sections describe the staff's review of the AP1000 process auxiliaries:

- 9.3.1, "Compressed and Instrument Air System"
- 9.3.2, "Plant Gas System"
- 9.3.3, "Primary Sampling System"
- 9.3.4, "Secondary Sampling System"
- 9.3.5, "Equipment and Floor Drainage System"
- 9.3.6, "Chemical and Volume Control System"
- 9.4, "Air Conditioning, Heating, Cooling, and Ventilation System"

9.3.1 Compressed and Instrument Air System

The staff reviewed the compressed and instrument air system (CAS) in accordance with the guidance of SRP Section 9.3.1, "Compressed Air System." Conformance with the acceptance criteria of the SRP forms the basis for concluding whether the instrument air subsystem of the CAS satisfies the following requirements:

- GDC 1, "Quality Standards and Records," as it relates to systems and components being designed, fabricated, and tested to quality standards in accordance with the importance of the safety functions to be performed

- GDC 2, as it relates to the capability of safety-related CAS components to withstand the effects of earthquakes

- GDC 5, as it relates to the capability of shared systems and components to perform required safety functions

Either single-unit or multiple-unit sites can use the AP1000 design. Nonetheless, in DCD Tier 2, Section 3.1.1, the applicant states that the AP1000 design is for a single-unit plant; if more than one unit is built on the same site, multiple units will not share the safety-related systems. If the COL applicant referencing the AP1000 design will be required to apply for the evaluation of the units' compliance with the requirements of GDC 5, "Sharing of Structures, Systems, and Components," with respect to the capability of shared SSCs important to safety to perform their required safety functions.

As identified in DCD Tier 2, Table 3.2-3, the CAS components, with the exception of the containment penetration piping and isolation valves, are classified as non-nuclear-safety-related and nonseismic. The quality assurance requirements of Appendix B to 10 CFR Part 50 do not apply. The containment penetration piping and isolation valves are classified as safety Class 2, seismic Category I, quality group B. DCD Tier 2, Section 9.3.1, Tables 9.3.1-1 to 9.3.1-4, and Figure 9.3.1-1 provide the system description, components, and flow diagrams, respectively.

The CAS consists of the following subsystems:

- the instrument air system
- the service air system

- the high-pressure air system

The CAS has no safety-related function other than containment isolation. The major components of the CAS are located in the turbine building.

Generic Safety Issue (GSI) 43, "Reliability of Air Systems," discusses the safety aspects of air systems in nuclear power plants. Issuance of Generic Letter (GL) 88-14, "Instrument Air Supply System Problems Affecting Safety-Related Equipment," resolved GSI 43. The GL requested that licensees and applicants review the recommendations of NUREG-1275, "Operating Experience Feedback Report," and perform a design and operations verification of the system. Section 20.3 of this report provides a complete discussion of how the AP1000 design addresses GSI 43. In DCD Tier 2, Section 9.3.7 Westinghouse states that the COL applicant will address GSI 43 as part of training and procedures identified in DCD Tier 2, Section 13.5. This COL Action Item, as it applies to GSI 43, is discussed in greater detail in Section 20.3 of this report. This is COL Action Item 9.3.1-1.

9.3.1.1 Instrument Air Subsystem

The instrument air subsystem provides high-quality instrument air, as specified in the ANSI/Instrument, Systems, and Automation Society (ISA) S7.3-1981, "Quality Standard for Instrument Air," which is specified in SRP Section 9.3.1. The intake filters for the instrument air subsystem prevent particulates 10 microns and larger from entering the air supply to the compressors.

Sample points are provided downstream of the air dryers in the instrument air subsystem to monitor the air quality supplied by each compressor. Periodic checks ensure high-quality instrument air, as specified in the ANSI/ISA S7.3-1981 standard.

Air-operated valves that are essential for safe shutdown and accident mitigation are designed to actuate to the fail-safe position upon loss of air pressure. DCD Tier 2, Table 9.3.1-1, identifies the safety-related air-operated valves supplied by the instrument air subsystem. There are no safety-related air-operated valves that rely on safety-related air accumulators to actuate to the fail-safe position upon loss of air pressure.

DCD Tier 2, Section 9.3.1.4, states that during the initial plant testing before reactor startup, safety systems utilizing instrument air will be tested to verify fail-safe operation of air-operated valves upon sudden loss of instrument air or gradual reduction of air pressure, as described in RG 1.68.3, "Preoperational Testing of Instrument and Control Air Systems." In addition, DCD Tier 2, Section 14.2.9.4.10, states that testing is performed to verify the fail-safe positioning of safety-related air-operated valves for sudden loss of instrument air or gradual loss of pressure, as described in DCD Tier 2, Section 9.3.1.4.

Therefore, the AP1000 design complies with the guidance of ANSI/ISA-S7.3, as it relates to supplying clean, dry, oil-free air to safety-related components, and the guidance of RG 1.68.3, as it relates to the testing of the CAS. On this basis, the staff concludes that the CAS complies with the requirements of GDC 1, with respect to systems and components important to safety being designed, fabricated, and tested to quality standards commensurate with the importance of the safety functions to be performed.

9.3.1.2 Service Air Subsystem

The service air subsystem is the supply source for plant breathing air. Portable, individually packaged, air purification equipment can be attached to any service air subsystem outlet to improve the service air quality to a minimum of Quality Verification Level D as defined in ANSI/CGA G-7.1. The breathing air purification package consists of replaceable cartridge-type filters, a pressure regulator, carbon monoxide monitoring equipment, air supply hoses, and air supply devices. A catalytic conversion to carbon dioxide within the package controls carbon monoxide. The service air subsystem is not connected to the instrument air subsystem.

9.3.1.3 High-Pressure Air Subsystem

The air compressor of the high-pressure air subsystem has an integral air purification system to produce air for high-pressure applications. This integral high-pressure air purification system utilizes a series of replaceable cartridge-type filters to produce breathing quality air. The high-pressure air subsystem supplies Quality Verification Level E air, as defined in ANSI/CGA G-7.1, and the high-pressure air compressor is checked regularly to verify that the breathing air meets these standards. A catalytic conversion to carbon dioxide within the package controls carbon monoxide. Breathing air connections to the high-pressure air subsystem are incompatible with the breathing air connections of the service air subsystem to prevent attachment of the portable air purification equipment to the high-pressure air subsystem.

The onsite standby DGs provide an alternate source of electrical power for the high-pressure air compressor.

The high-pressure air subsystem is classified as a high-energy system. The high-pressure compressor and receiver are located in the turbine building, which contains no safety-related equipment or structures. Air piping in safety-related areas is 2.54 cm (1 in.) or less in diameter, and an analysis of the dynamic consequences of a rupture is not required. This subsystem is not required to operate following a design-basis accident nor is it used for safe shutdown of the plant.

9.3.1.4 Conclusions

The CAS does not have to comply with Regulatory Position C.1 of RG 1.29 because, with the exception of the inner and outer containment isolation valves and lines in between, the system is non-safety-related. Instead, the CAS complies with Regulatory Position C.2 of RG 1.29 because the CAS is not required to remain functional and its failure as a result of an SSE will not reduce the functioning of any plant feature included in Items 1.A through 1.Q of Regulatory Position C.1 of RG 1.29 to an unacceptable safety level. The SSCs are non-nuclear-safety class, but the structure housing the CAS (turbine building) has a seismic Category II designation. The structure’s design and construction ensure that the SSE will not cause any failure that would adversely affect other safety systems, as stated in DCD Tier 2, Section 3.2.1 and Table 3.2-1. Therefore, the system complies with GDC 2, as it relates to the ability of the system to withstand the effects of earthquakes.

On the basis of the preceding review, the staff concludes that the CAS complies with GDC 1, 2, and 5, as referenced in SRP Section 9.3.1 and, therefore, is acceptable.

9.3.2 Plant Gas System

The plant gas system (PGS) provides hydrogen, carbon dioxide, and nitrogen gases to plant systems as required. The PGS does not supply other gases, such as oxygen, methane, acetylene, and argon, which are supplied in smaller individual containers. The hydrogen portion of the PGS supplies hydrogen to the main plant electrical generator for cooling and to other plant auxiliary systems. The carbon dioxide portion stores and supplies carbon dioxide to the generator to purge hydrogen and air during layup or plant outages. The nitrogen portion of the PGS supplies nitrogen for pressurizing, blanketing, and purging various plant components.

The PGS is required for normal plant operation and startup of the plant. The PGS has no safety-related function. Failure of the system does not compromise any safety-related system, nor does it prevent safe reactor shutdown.

The main steam isolation valves (MSIVs) and the main feedwater isolation valves (MFIVs) are safety-related valves that use compressed nitrogen stored within the valve operators as the motive force to close the valves. Note 21 on DCD Tier 2, Figure 10.3.2-1, specifies that the MSIVs and MFIVs are pneumatic-hydraulically actuated with a sealed nitrogen accumulator that provides the stored energy to close the valve. Portable high-pressure nitrogen bottles, which are part of the PGS, provide nitrogen makeup for these valves, if needed, using temporary connections on the valves. Failure of these bottles has no effect on the safety-related function of the MSIVs and MFIVs.

In DCD Tier 2, Section 6.4, “Habitability Systems,” the applicant addresses the effect of the PGS on MCR habitability, including explosive gases and burn conditions for those gases. For explosions, the design of the PGS conforms to RG 1.91, “Evaluations of Explosions Postulated to Occur on Transportation Routes Near Nuclear Power Plants.” RG 1.91 provides guidance on acceptable methods to comply with GDC 4, with respect to the dynamic effects of explosions of hazardous materials that may be carried near transportation routes.

The nitrogen and carbon dioxide portions of the PGS are located inside the turbine building, and the hydrogen system storage is located outdoors at the hydrogen storage tank area. DCD Tier 2, Section 3.5, “Missile Protection,” contains an analysis of storage tanks as a potential missile source. Section 3.5.1.1 of this report also discusses this scenario.

The staff concludes that the PGS is acceptable because it follows the guidance of RG 1.91.

9.3.3 Primary Sampling System

The staff reviewed DCD Tier 2, Section 9.3.3, “Primary Sampling System,” in accordance with SRP Section 9.3.2, “Process and Post-Accident Sampling Systems.” The acceptability of the primary sampling system (PSS) is based on whether there are provisions to isolate the system to limit radioactive releases; whether the system meets the intended function of collecting and delivering representative samples of fluids from various plant fluid systems to a laboratory for analysis; and whether it meets the requirements for seismic design and quality group classification described in the following GDC:

- GDC 1, as it relates to the design of the components to standards commensurate with the importance of their safety functions

- GDC 2, as it relates to the design of the components to withstand the effects of natural phenomena

The applicant can meet the requirements of GDC 1 and 2 by following the guidance in RG 1.26, “Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants,” and RG 1.29.

9.3.3.1 Summary of Technical Information

The function of the PSS is to collect liquid and gaseous samples and to provide for local grab samples during normal operation. The system includes provisions to route sample flow to a laboratory for continuous or intermittent sample analysis. The proposed design uses common sampling lines and points. The PSS includes piping, valves, heat exchangers, and other components associated with the system from the point of sample withdrawal from a fluid system up to the analyzing station, sampling station, or local sampling point. The system includes equipment to collect representative samples of various process fluids in a manner that adheres to the ALARA principles during normal and postaccident conditions. In addition, the system design provides a safety-related hydrogen analyzer for monitoring containment atmosphere during a postulated LOCA.

9.3.3.1.1 Process Sampling

During normal plant operations, the PSS collects samples for analysis from the reactor coolant system (RCS), the auxiliary primary process system streams, and the containment atmosphere, as specified in DCD Tier 2, Tables 9.3.3-1 and 9.3.3-2. The results are used to perform the following functions:

- monitor core reactivity
- monitor fuel rod integrity
- evaluate ion exchanger (demineralizer) and filter performance
- specify chemical additions to the various systems
- maintain acceptable hydrogen levels in the RCS
- detect radioactive material leakage

9.3.3.1.2 Postaccident Sampling

The PSS does not have a specific postaccident sampling capability; however, the design of this system allows for collection and analysis of highly radioactive samples of reactor coolant for boron, containment sump for pH, and containment atmosphere for hydrogen and other fission products.

The requirements for the postaccident sampling system are in 10 CFR 50.34(f)(2)(viii). The reactor coolant and containment atmosphere sampling line systems should permit personnel to take a sample under accident conditions promptly and with doses less than 50 milisieverts (5 rem) whole body and 500 milisieverts (50 rem) extremity. The radiological spectrum analysis facilities should be able to promptly quantify certain radionuclides that are indicators of the degree of core damage. In addition to the radiological analyses, certain chemical analyses are necessary for monitoring reactor conditions.

The NRC published a model safety evaluation report on eliminating the postaccident sampling system requirements from the technical specifications (TS) for operating plants (Volume 65, Number 211, of the Federal Register, dated October 31, 2000). In DCD Tier 2, Section 1.9.3, Item (2)(viii), the applicant states that the AP1000 sampling design basis is consistent with the approach in the model safety evaluation and not with the previous guidance of NUREG-0737, "Clarification of TMI Action Plan Requirements," and RG 1.97, "Instrumentation for Light-Water-Cooled Nuclear Power Plants to Assess Plant and Environs Conditions During and Following an Accident." The guidance of the model safety evaluation report discusses contingency plans to obtain and analyze highly radioactive postaccident samples from the RCS, the containment sump, and the containment atmosphere. The applicant states in DCD Tier 2, Section 1.9.3, that the AP1000 design is consistent with the model safety evaluation report guidance. Therefore, the staff finds the applicant's elimination of the postaccident sampling system from the TS for the AP1000 to be acceptable.

9.3.3.2 Staff Evaluation

The intended function of the PSS is to collect and analyze liquid and gaseous samples from the RCS, the auxiliary primary process system streams, and the containment atmosphere. Although the PSS has no safety-related function, some of its sampling lines may connect to safety-related systems. Therefore, to meet the requirements of GDC 1 and 2, the seismic and quality group classification of these lines, associated components, and instruments must conform to the classification of the system to which they are connected. DCD Tier 2, Table 3.2-3, addresses the component classification for the PSS. The PSS components are classified as ASME Class 2 and 3, seismic Category I. This system meets the quality standards in GDC 1 and the seismic requirements of GDC 2 because its design conforms to the classification of the system to which each sampling line and component are connected, in accordance with the regulatory positions in RGs 1.26 and 1.29.

In addition, the PSS provides for system isolation in the event of an accident to limit radioactive releases through containment isolation valves and purging the sample streams back to the system of origin or the appropriate radwaste system. DCD Tier 2, Section 6.2.3, "Containment Isolation System," discusses the isolation function of this system, and Section 6.2.4 of this report evaluates that function. The staff reviewed and evaluated the design of this system and determined that it includes the components to meet the function and operational requirements of the PSS.

9.3.3.3 Conclusions

The staff's review has determined that the design of the PSS is acceptable because it performs the intended function of sampling liquid and gaseous process streams to monitor plant and various system conditions and provides for isolation of the system to limit radiation releases. In addition, by conforming to RGS 1.26 and 1.29, the PSS meets the requirements of GDC 1 and 2.

9.3.4 Secondary Sampling System

The staff reviewed DCD Tier 2, Section 9.3.4, "Secondary Sampling System," in accordance with SRP Section 9.3.2, "Process and Post-Accident Sampling Systems." The secondary sampling system (SSS) is acceptable if it can perform the intended function of collecting and delivering representative samples of fluids from various plant fluid systems to a laboratory for analysis and can satisfy the requirements of GDC 13, “Instrumentation and Control,” as they relate to monitoring variables that can affect the fission process, the integrity of the reactor core, and the reactor coolant pressure boundary. Assessment and understanding of integrated secondary plant operations rely on data from this system.

9.3.4.1 Summary of Technical Information

The function of the SSS is to collect and deliver representative samples of fluids from various plant fluid systems to a laboratory for analysis. The SSS relies on continuous in-line analyses for monitoring the secondary chemistry that is required for assessing and understanding integrated secondary plant operations. It samples water from the turbine cycle, demineralized water treatment, and circulated water systems. The SSS can provide information on the following parameters:

- chloride
- sulfate
- silica
- iron
- copper content
- dissolved oxygen
- pH
- conductivity levels

The system offers grab sample capability as a backup method to obtain samples and for use in calibrating the in-line instrumentation. Continuous monitoring of the steam generator (SG) blowdown lines checks for radioactivity caused by primary to secondary tube leaks. In case of high radioactivity, the system automatically isolates this flow path, which prevents introduction of radioactive fluids into the SSS.

9.3.4.2 Staff Evaluation

The staff review has verified that the SSS is capable of collecting and delivering for analysis samples of fluids from secondary systems such as the turbine, demineralized water system, and circulating water system. The system provides a grab sample capability as a backup. These are non-safety-related functions. In addition, the SSS has an isolation capability to prevent leakage of radioactive fluid from the SG boundary. Therefore, the SSS complies with GDC 13, and the staff finds it to be acceptable.

9.3.4.3 Conclusions

The SSS instrumentation is capable of monitoring variables and systems over their anticipated range for normal operation, anticipated operational occurrences, and for accident conditions. This includes both the non-safety-related and the safety-related function of SG isolation. Therefore, the SSS satisfies GDC 13.

9.3.5 Equipment and Floor Drainage System

The staff reviewed the equipment and floor drainage system (EFDS) in accordance with the guidance of SRP Section 9.3.3, “Equipment and Floor Drainage System.” Conformance with the acceptance criteria of the SRP forms the basis for concluding whether the EFDS satisfies the following requirements:

- GDC 2, as it relates to the capability of safety-related portions of the system to withstand the effects of earthquakes

- GDC 4, as it relates to the capability of the system to withstand the effects of flooding and the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents

- GDC 60, as it relates to providing a means to suitably control the release of radioactive materials in liquid effluent, including during anticipated operational occurrences

The EFDS consists of the radioactive waste drain system (WRS) and the nonradioactive WWS. These systems collect liquid wastes from equipment and floor drains during normal operation, startup, shutdown, and refueling. The liquid wastes are separated according to the type of waste and are then transferred to appropriate processing and disposal systems. Section 9.2.9 of this report discusses the WWS.

The WRS consists of the following equipment:

- equipment drains
- floor drains
- collection piping
- vents
- traps
- cleanouts
- sampling connections
- valves
- collection sumps
- drain tanks
- sump pumps
- drain tank pumps
- discharge piping

The WRS collects radioactive, borated, chemical, and detergent liquid wastes at atmospheric pressure from equipment and floor drainage of the radioactive portions of the auxiliary building, the annex building, the radwaste building, and the containment building. These radioactive liquid wastes are routed to either the auxiliary building sump, the containment sump, or the reactor coolant drain tank. The contents of the sumps and the drain tank are pumped to the WLS for processing. DCD Tier 2, Sections 9.3.5 and 11.2, Tables 9.3.5-1, 11.2-2, and 11.2-4, and Figures 9.3.5-1, 11.2-1, and 11.2-2, respectively, provide the WRS system description, components, and flow diagrams.

The auxiliary building consists of a radiologically controlled area (RCA) and an NRCA that are physically separated by structural walls and floor slabs, so that flooding in the RCA will not cause flooding in the NRCA. The drain system in the RCA is completely separate from NRCA drains to prevent cross-contamination of nonradioactive areas. There are no permanent connections between the WRS and nonradioactive piping. However, the system provides for temporary diversion of contaminated water from normally nonradioactive drains to the WLS. Section 9.2.9 of this report discusses the detection and diversion of radioactive fluids in the nonradioactive WWS. As discussed above, the WRS is designed to prevent the inadvertent transfer of contaminated fluids to a noncontaminated drainage system for disposal. On the basis of its review, the staff concludes that the WRS complies with the requirements of GDC 60, with respect to preventing the inadvertent transfer of contaminated fluids to a noncontaminated drainage system for disposal.

As identified in DCD Tier 2, Table 3.2-3, the WRS components are classified as non-safety-related, nonseismic, Quality Group D, with the following exceptions:

- containment isolation valves in the discharge line from the containment sump and the reactor coolant drain tank

- backflow preventers in the drain lines from containment cavities to the containment sump

- drain line piping from the backflow preventers to the containment cavities

These are classified as Safety Class 2 or 3, seismic Category I, Quality Group B or C.

DCD Tier 2, Section 9.3.5.1.1, states that the EFDS is designed to prevent damage to safety-related systems, structures, and equipment. Safety-related components are not damaged as a result of EFDS component failure from a seismic event. Single failures of the EFDS and its equipment will not prevent the proper function of any safety-related equipment. Therefore, the staff concludes that the design presented in DCD Tier 2 complies with Regulatory Positions C.1 and C.2 of RG 1.29, and that the WRS complies with the requirements of GDC 2, with respect to the capability to withstand the effects of earthquakes.

Operation of the sump pumps and drain tank pumps is not required to mitigate the consequences of design-basis accidents or flooding events. Section 3.4.1 of this report describes the flood protection aspects of the AP1000. Sump pumps inside the containment are interlocked with the associated containment isolation valves. The pumps trip and the isolation valves close on receipt of containment isolation signals to prevent the uncontrollable release of primary coolant outside the containment. Equipment drains are of adequate size to meet the flow requirements. Sump pumps and drain tank pumps discharge at a flow rate adequate to prevent sump overflow for drain rates anticipated during normal plant operation, maintenance, decontamination, fire suppression system testing, and firefighting activities. Sump and drain tank capacities provide a storage capacity consistent with an operating period of approximately 10 minutes with one pump operating. The design of the drain headers minimizes plugging by making them at least 10.2 cm (4 in.) in diameter, which is large enough to accommodate more than the design flow, and by making the flow path as straight as possible. On the basis of its review, the staff concludes that the WRS complies with the requirements of GDC 4, with respect to the capability to withstand the effects of flooding and the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents.

On the basis of the above review, the staff concludes that the WRS complies with GDC 2, 4, and 60, as referenced in Section 9.3.3 of the SRP and, therefore, is acceptable.

9.3.6 Chemical and Volume Control System

The staff reviewed DCD Tier 2, Section 9.3.6, “Chemical and Volume Control System,” in accordance with the applicable guidance in SRP Section 9.3.4, “Chemical and Volume Control System (PWR) (Including Boron Recovery System).” The SRP indicates that the CVS is acceptable if it includes components and piping, from the letdown line of the primary system to the charging lines, that provide makeup to the primary system and the reactor coolant pump seal water system. It must also meet the requirements for system performance of necessary functions during normal, abnormal, and accident conditions described in the following GDC:

- GDC 1, as it relates to system components being assigned quality group classifications and application of quality standards in accordance with the importance of the safety function to be performed

- GDC 2, as it relates to structures housing the facility and the system itself being capable of withstanding the effects of earthquakes

- GDC 5, as it relates to shared systems and components important to safety being capable of performing required safety functions

- GDC 14, “Reactor Coolant Pressure Boundary,” as it relates to ensuring RCP boundary material integrity by means of the CVS being capable of maintaining RCS water chemistry

- GDC 29, “Protection Against Anticipated Operational Occurrences,” as it relates to the reliability of the CVS in providing negative reactivity to the reactor by supplying borated water to the RCS in the event of anticipated operational occurrences

- GDC 33, “Reactor Coolant Makeup,” and GDC 35, “Emergency Core Cooling System,” as they relate to the CVS capability to supply reactor coolant makeup in the event of small breaks or leaks in the RCPB, to function as part of the emergency core cooling system (ECCS) assuming a single active failure coincident with the LOOP, and to meet ECCS TSs

- GDC 60 and 61, as they relate to CVS components having provisions for venting and draining through closed systems

9.3.6.1 Summary of Technical Information

The CVS in the AP1000 design consists of regenerative and letdown heat exchangers, demineralizers and filters, makeup pumps, tanks, and associated valves, piping, and instrumentation. In addition, the CVS is a non-safety-related system, and its operation is not required to mitigate design-basis events. DCD Tier 2, Section 9.3.6.1.2, describes the following non-safety-related functions performed by the CVS:

- Purification: The CVS removes radioactive corrosion products, ionic fission products, and fission gases from the RCS to maintain low RCS activity levels.

- Reactor coolant system inventory control and makeup: The CVS provides a means to add and remove mass from the reactor coolant system, as required, to maintain the programmed inventory during normal plant operations.

- Chemical shim and chemical control: The CVS provides the means to vary the boron concentration in the RCS and to control the RCS chemistry for limiting corrosion and enhancing core heat transfer.

- Oxygen control: The CVS maintains the proper conditions in the RCS to minimize corrosion of the fuel and primary surfaces (i.e., adding dissolved hydrogen to eliminate free oxygen and to prevent ammonia formation during power operations and introducing an oxygen scavenger at low RCS temperatures during startup from cold shutdown conditions).

- Filling and pressure testing the RCS: The CVS provides a means for filling and pressure testing the RCS.

- Borated makeup: The CVS provides makeup to the PXS accumulators, core makeup tanks (CMTs), IRWST, and the SFP at various boron concentrations.

The following safety-related functions connected to the CVS are important to reactor safety:

- containment isolation of the CVS lines penetrating containment

- termination of inadvertent RCS boron dilution

- isolation of makeup on a steam generator (SG) or pressurizer high level signal

- preservation of the integrity of the RCS pressure boundary, including isolation of normal CVS letdown from the RCS

9.3.6.2 Staff Evaluation

During an accident, the CVS is not required to provide emergency core cooling or boration. However, the makeup pumps can provide RCS makeup following an accident, such as a small LOCA, and can furnish pressurizer auxiliary spray to reduce RCS pressure in certain accident scenarios, thereby improving the reliability of the plant.

DCD Tier 2, Section 9.3.6.2, “System Description,” describes the CVS design, which consists of regenerative and letdown heat exchangers, demineralizers and filters, makeup pumps, tanks, and associated valves, piping, and instrumentation. The CVS purification loop is located entirely inside the containment and operates at RCS pressure in a closed loop without the CVS makeup pumps. It uses the developed head of the reactor coolant pumps (RCPs) as a motive force for the purification flow. The primary coolant passes through the regenerative and letdown heat exchangers, where it is cooled to the temperature compatible with the resin in the demineralizer. The coolant then passes through one of the two demineralizers containing mixed bed resin.

After passing through the demineralizers, the coolant travels through the secondary side of the regenerative heat exchanger back to the primary loop. During plant shutdown, when the pumps are not operating, the RNS provides the motive force for the purification loop.

The CVS has enough capacity to accommodate minor leakage from the RCS and provides inventory control during plant heatups and cooldowns. In addition to controlling coolant inventory in the primary coolant system, the CVS provides borated water for PXS accumulators, CMTs, and the SFP. It is also used for filling and pressure testing of the RCS after maintenance and refueling.

Control of pH is achieved through injecting lithium hydroxide from the chemical mixing tank into the makeup water. Since the CVS is a non-safety-related system, its operation is not required to mitigate design-basis events. Therefore, the CVS does not have to meet the safety-related system requirements. However, the CVS provides the first line of defense during an accident to prevent unnecessary actuation of PXSs.

The staff reviewed the design of the CVS and its ability to maintain the required water inventory and quality in the RCS, provide pressurizer auxiliary spray, control the boron neutron absorber concentration in the RCS, and control the primary water chemistry and reduce coolant radioactivity level. In addition, the staff reviewed the system’s ability to provide recycled coolant for demineralized water makeup for normal operation and high-pressure injection flow to the ECCS in the event of postulated accidents.

The staff also noted the discussion in DCD Tier 2, Section 9.3.6.5, “Design Evaluation,” which addresses the basis of the CVS design. DCD Tier 2, Section 3.1, “Conformance with Nuclear Regulatory Commission General Design Criteria,” discusses the specific GDC applicable to this system (i.e., GDC 1, 2, 5, 14, 29, 33, 35, 60, and 61). In addition, DCD Tier 2, Section 1.9, “Compliance with Regulatory Criteria,” discusses compliance with RGs 1.26 and 1.29.

On the basis of the information provided in those sections of DCD Tier 2, the staff finds that the CVS meets the following:

- GDC 1 and RG 1.26 by assigning quality group classifications to system components in accordance with the importance of the safety function to be performed

- GDC 2 and RG 1.29 by designing safety-related portions of the system to seismic Category I requirements

- GDC 5 by designing AP1000 as a single-unit plant and specifying that additional units on the same site will not share safety-related systems

- GDC 14 by providing the necessary components to maintain reactor coolant purity and material compatibility to reduce corrosion

- GDC 29 by including the necessary components to provide negative reactivity through injection of borated water into the RCS

- GDC 60 and 61 by designing this system to be capable of confining radioactivity by venting and collecting drainage through closed systems

Passive systems satisfy GDC 33 and 35. However, non-safety-related portions of the CVS are designed with the capability to provide borated makeup to the RCS following accidents, such as small LOCAs, SG tube rupture events, and small steamline breaks.

9.3.6.3 Conclusions

DCD Tier 2, Section 9.3.6.5, summarizes the compliance of the CVS with regulatory requirements and guidance. The applicant indicates that it based the design of the CVS on the GDC (1, 2, 5, 14, 29, 33, 35, 60, and 61) and RGs specified in SRP Section 9.3.4. Although the AP1000 CVS is not a safety-related system and its design need not strictly adhere to the criteria listed in the SRP, the applicant compared the AP1000 CVS design to the GDC requirements and concluded that it meets these requirements, which were discussed for the AP1000 in DCD Tier 2, Section 3.1. The staff agrees with this conclusion.

In addition, the staff concludes that the design of the CVS includes the components and piping to provide inventory control and chemically controlled makeup to the primary system. Also, the CVS includes components to isolate containment and preserve the integrity of the reactor coolant pressure boundary (RCPB). Therefore, the staff concludes that because the CVS meets the intent of GDC 1, 2, 5, 14, 29, 33, 35, 60, and 61, it is acceptable.

9.4 Air Conditioning, Heating, Cooling, and Ventilation System

In DCD Tier 2, Section 3.1.1, the applicant states that the AP1000 design is a single-unit plant; if multiple units share the same site, they will not share safety-related systems. Thus, the individual plants will maintain the independence of all safety-related systems and their support systems. The staff determined that the HVAC systems design described in the DCD does not share SSCs with other nuclear power units. Therefore, the HVAC cooling systems meet the requirements of GDC 5. DCD Tier 2, Table 9.4-1, lists the standards to which the various components of the HVAC systems are designed.

The following sections describe the staff’s review of the AP1000 air conditioning, heating, cooling, and ventilation systems:

- 9.4.1, “Nuclear Island Nonradioactive Ventilation System”
- 9.4.2, “Annex/Auxiliary Buildings Nonradioactive HVAC System”
- 9.4.3, “Radiologically Controlled Area Ventilation System”
- 9.4.4, “Balance-of-Plant Interfaces”
- 9.4.5, “Engineered Safety Features Ventilation System”
- 9.4.6, “Containment Recirculation Cooling System”
- 9.4.7, “Containment Air Filtration System”
- 9.4.8, “Radwaste Building HVAC System”
- 9.4.9, “Turbine Building Ventilation System”
- 9.4.10, “Diesel Generator Building Heating and Ventilation System”

- 9.4.11, “Health Physics and Hot Machine Shop HVAC System”

Table 9.4-1 of this report lists the relevant codes and standards for the design, maintenance, and testing of air conditioning, heating, cooling, and ventilation systems.

The NRC staff stated, as part of RAI 410.009, that the AP1000 design should comply with the latest revisions of the applicable codes and standards for the following systems:

- radiologically controlled area ventilation system (VAS)
- nuclear island nonradioactive ventilation system (VBS)
- containment recirculating cooling system (VCS)
- main control room emergency habitability system (VES)
- containment air filtration system (VFS)
- health physics and hot machine shop HVAC system (VHS)
- radwaste building HVAC system (VRS)
- turbine building ventilation system (VTS)
- annex/auxiliary buildings nonradioactive HVAC system (VXS)
- DG building heating and ventilation system (VZS)

The RAI also asked that the applicant revise the DCD, as necessary. In a letter dated February 14, 2003, the applicant provided additional information that revised its original response to RAIs 410.007 and 410.009. This response asserts that the AP1000 HVAC design meets the codes and standards and issue date identified in DCD Tier 2, Section 9.4.13, “References,” and that these codes and standards are up to date as of the submittal date of the DCD to the NRC. The applicant further assured the staff that the use of these codes and standards will result in a technically suitable HVAC design for the AP1000. The NRC staff expects that a future DCD revision will include the codes and standards (including NRC guidance documents) that are in effect as of the submittal date of DCD Tier 2 (March 28, 2002) and will update the references identified in DCD Tier 2, Sections 6.4.8, 9.4.13, and Appendix 1A. In a letter dated May 21, 2003, the applicant responded to RAI 410.007. Open Item 9.4-1 in the DSER noted that the staff had insufficient time to review this response. The staff reviewed the May 21, 2003, letter and the DCD and determined that the DCD references the latest revisions of the codes and standards relevant to the HVAC systems. Therefore, Open Item 9.4-1 is resolved.

9.4.1 Nuclear Island Nonradioactive Ventilation System

The staff reviewed the VBS in accordance with SRP Section 9.4.1, “Control Room Area Ventilation System.” Conformance with the SRP acceptance criteria forms the basis for determining whether the VBS satisfies the following requirements:

- GDC 2, regarding the capability to withstand earthquakes

- GDC 4, regarding maintaining environmental conditions in essential areas compatible with the design limits of the essential equipment located in those areas during normal, transient, and accident conditions

- GDC 5, regarding sharing systems and components important to safety

- GDC 19, “Control Room,” regarding maintaining the control room in a safe, habitable condition under accident conditions by providing adequate protection against radiation and toxic gases

- GDC 60, regarding the capability to suitably control release of gaseous radioactive effluents to the environment

The VBS provides safety-related, design-basis functions to (1) monitor the air supply for radioactive particulate and iodine concentrations inside the main control room envelope (MCRE), and (2) isolate the safety-related, seismic Category I HVAC piping penetrating the MCRE based on the detection of “high-high” particulate or iodine radioactivity in the supplied air or on the extended loss of ac power supporting operation of the main control room (MCR) emergency habitability system as described in Section 6.4 of this report. The system is designed to maintain proper environmental conditions and control of contaminant levels. The VBS maintains the MCR and technical support center (TSC) carbon dioxide levels below 0.5-percent concentration and keeps the air quality within the guidelines of Table 1 and Appendix C, Table C-1, to the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) Standard 62-1999, “Ventilation for Acceptable Indoor Air Quality.” The applicant states that the VBS is non-safety-related; however, if the system is operational and ac power is available, the system provides for habitability inside the MCRE (within the guidelines of SRP Section 6.4, “Control Room Habitability System”) and the TSC (within the guidelines of NUREG-0696, “Functional Criteria for Emergency Response Facilities”). However, since the VBS is non-safety-related, there is no basis for the staff to assume that it will be operable during a design basis accident.

The VBS can provide habitability because its design, construction, and testing conform to GSI B-36, “Develop Design, Testing, and Maintenance Criteria for Atmosphere Cleanup System Air Filtration and Adsorption Units for Engineered Safety Features Systems and for Normal Ventilation Systems”; GSI B-66, “Control Room Infiltration Measurements”; RG 1.140, Revision 2, “Design, Inspection and Testing Criteria for Air Filtration and Adsorption Units of Normal Atmosphere Cleanup Systems in Light-Water-Cooled Nuclear Power Plants,” as discussed in DCD Tier 2, Chapter 1.0, Appendix 1A, and ASME N-510-1989, “Testing of Nuclear Air Cleaning Systems.” Chapter 20 of this report discusses GSI B-36.

In addition, the applicant state in DCD Tier 2, Section 9.4.12, “Combined License Information,” that COL applicants referencing the AP1000 design will implement a program to maintain compliance with ASME/ANSI AG-1-1997, “Code on Nuclear Air and Gas Treatment,” and Addenda AG-1a-2000, “Housings”; ASME N-509-1989, “Nuclear Power Plant Air-Cleaning Units and Components”; ASME N-510-1989; and RG 1.140, Revision 2, for portions of the VBS and VFS identified in DCD Tier 2, Sections 9.4.1 and 9.4.7. The staff finds this acceptable because the applicant referred to industry codes and standards that are specified in RG 1.140, Revision 2. This is COL Action Item 9.4.1-1.

For the post-72-hour design-basis accident, the specific function of the VBS is to maintain the MCR below a temperature approximately 2.5 °C (4.5 °F) above the average outdoor temperature. In addition, the VBS is designed to maintain the instrumentation and control (I&C) rooms (Divisions B and C) below the qualification temperature of the I&C equipment (49 °C or 120 °F) for the post-72-hour design-basis accident. The ancillary fans are intended to meet the above post-72-hour ventilation criteria for the MCR and Class 1E I&C rooms. Section 8.3 of this report discusses the staff's evaluation of the post-72-hour power supply.

The VBS consists of the following subsystems:

- The MCR/TSC HVAC subsystem serves the MCR and the TSC.

- The Class 1E electrical room HVAC subsystem serves the Class 1E dc equipment rooms, electrical penetration rooms, battery rooms, and I&C rooms, remote shutdown area, reactor cooling pump trip switchgear rooms, and adjacent corridors.

- The PCS valve room heating and ventilating subsystem serves the PCS valve room.

Descriptions, design parameters, instrumentation (including indications and alarms), and figures for the VBS and the interfacing VES appear in DCD Tier 2, Sections 6.4, 9.4.1, and 15.6.5.3; Tables 3.2-1, 6.4-1 through 6.4-3, 9.4.1-1, and 15.6.5-2; and Figures 1.2-8, 6.4-1, 6.4-2, and 9.4.1-1. DCD Tier 2, Section 7.3, "Engineered Safety Features," discusses instrumentation for the VES and VBS. DCD Tier 2, Section 11.5, "Radiation Monitoring," gives details of radiation monitors, including testing and inspection. Section 9.2.7 of this report discusses the staff's evaluation of the chilled water system, and Section 9.5.1 discusses the staff's evaluation of fire protection. Table 9.4-1 of this report describes the industry standards applicable to the HVAC system, including components of the VBS.

The MCRE penetrations include isolation valves, interconnecting piping, and vent and test connections with manual valves that are classified as safety Class C and seismic Category I. The MCRE isolation valves have electrohydraulic operators and are designed to fail closed during a LOOP event. The TS for periodic testing and the inservice testing (IST) program include the safety-related isolation valves.

The design, construction, and testing of the MCR/TSC HVAC subsystem filtration unit configurations, including housing, internal components, ductwork, dampers, fans and controls, and the location of the fans on the filtered side of units, are in accordance with ASME N-509-1989, ASME N-510-1989, and RG 1.140, Revision 2. The ductwork for the supplemental air filtration subsystem and portions of the MCR/TSC HVAC subsystem that maintains the integrity of the MCR/TSC pressure boundary, during conditions of abnormal airborne radioactivity, is tested for leak tightness in accordance with ASME 510-1989.

The remaining supply and return/exhaust ductwork is tested in place for leakage in accordance with the 1985 Sheet Metal and Air-Conditioning Contractor's National Association (SMACNA), "HVAC Duct Leakage Test Manual." The high-efficiency particulate air (HEPA) filters are shop tested to verify an efficiency of at least 99.97 percent using a monodisperse 0.3-µm aerosol and constructed, qualified, and tested in accordance with ASME N-509-1989 and the 1996 Underwriters Laboratory (UL)-586, "High-Efficiency, Particular, Air-Filter Units." Postfilters downstream of the charcoal adsorbers have a minimum dioctyl-phthalate polydispersed (DOP) test efficiency of 95 percent. Each charcoal adsorber is a single assembly with welded construction and 100-mm (4-in.)-deep type III rechargeable adsorber cell. The charcoal adsorbers conform with NRC Inspection and Enforcement (IE) Bulletin 80-03, "Loss of Charcoal from Adsorber Cells," and are qualified, constructed, and tested in accordance with ASME/ANSI AG-1-1997 and Addenda AG-1a-2000, ASME N-509-1989, ASME N-510-1989, and RG 1.140, Revision 2. Laboratory tests must verify that a representative charcoal sample, used or new, has a minimum charcoal efficiency of 90 percent in accordance with RG 1.140, Revision 2, and test procedures and test frequency must conform with ASME N-510-1989.

The system ductwork flow is tested, balanced, and adjusted in accordance with SMACNA-1993, “HVAC Systems Testing, Adjusting, and Balancing.” Fire dampers or combination fire/smoke dampers are provided at duct penetrations through fire barriers to maintain the fire-resistance ratings of the barriers. The MCR/TSC HVAC and Class 1E electrical room HVAC subsystems are designed so that smoke, hot gases, and fire suppressant do not migrate from one fire area to another to the extent that they could adversely affect safe-shutdown capabilities, including operator actions. The MCRE areas, Class 1E equipment rooms, and the remote shutdown workstation room have fire or combination fire and smoke dampers to isolate each fire area from adjacent fire areas during and following a fire, in accordance with the National Fire Protection Association (NFPA) 90A, “Installation of Air Conditioning and Ventilation Systems.”

If the VBS is not available during the 72-hour period following the onset of a postulated design-basis accident, the VES provides passive heat sinks to limit the temperature rise in the MCRE, I&C rooms, and dc equipment rooms. The heat sinks consist primarily of the thermal mass of the concrete that makes up the ceilings and walls of these rooms. As described in DCD Tier 2, Section 6.4.2.2, a metal form is attached to the surface of the concrete at selected locations to enhance the heat-absorbing capacity of the ceilings. Metallic plates are attached perpendicularly to the ceiling metal form. These plates extend into the room and act as thermal fins to enhance the heat transfer from the room air to the concrete. The VBS cooling and heating capacity depends on the site interface parameters for maximum and minimum normal temperature conditions, as defined in DCD Tier 2, Table 2-1, as summarized in the following:

- The MCR/TSC HVAC subsystem maintains the MCR and TSC between 19.4 and 23.9 °C (67 to 75 °F) and 25 percent to 60 percent relative humidity. The VBS maintains the VES passive cooling heat sink below its initial design ambient air temperature limit of 23.9 °C (75 °F).

- The Class 1E electrical room HVAC subsystem maintains the Class 1E dc equipment rooms between 19.4 and 23.9 °C (67 to 75 °F); Class 1E electrical penetration rooms, Class 1E battery rooms, Class 1E instrumentation and control rooms, remote shutdown area, reactor cooling pump trip switchgear rooms, and adjacent corridors between 19.4 and 22.8 °C (67 to 73 °F); and HVAC equipment rooms between 10 to 29.4 °C (50 and 85 °F).

- The VBS maintains the Class 1E electrical room emergency passive cooling heat sink below its initial design ambient air temperature limit of 23.9 °C (75 °F).

- The VBS vents the Class 1 battery rooms to limit the hydrogen gas concentration to less than 2 percent by volume.

- The PCS valve room heating and ventilation subsystem maintains the PCS valve room at 10 to 48.9 °C (50 to 120 °F).

The single outside air intake serving the VBS conforms with the guidance of Section 6.4 of the SRP and RG 1.78, Revision 1, “Evaluating the Habitability of a Nuclear Power Plant Control

Room During a Postulated Hazardous Chemical Release." The MCR/TSC HVAC subsystem provides outside supply air to the plant through an outside air intake that is protected by an intake enclosure located on the roof of the auxiliary building at Elevation 153'-0". As stated in DCD Tier 2, Section 6.4.4, the fresh air intake of the MCR is located in excess of 45.7 m (150 ft) from the flue gas exhaust stacks of the onsite standby power DGs, and 91.4 m (300 ft) from the onsite standby power system fuel oil storage tanks. This distance precludes the combustion fumes or smoke from an oil fire from being drawn into the MCR. The fresh air intake is located more than 15.2 m (50 ft) below and more than 30.5 m (100 ft) laterally away from the plant vent discharge. The split-wing-type tornado protection dampers close automatically and can withstand the effects of 134 m/s (300 mph) wind.

As shown in DCD Tier 2, Figure 9.4.1-1, a fail-closed, electrohydraulically operated isolation damper at the inlet of each air filtration train can automatically isolate the fresh air supply from an air intake. Normally, one VBS air filtration unit train isolation damper is open, and the other air filtration unit train isolation damper is closed. There are two fail-closed isolation dampers in series in the common outside air supply to each of the normal air handling units. DCD Tier 2, Figure 9.4.1-1, shows the radiation monitors and outside air isolation dampers. Redundant smoke monitors at the outside air intake continuously monitor the outside air. Redundant safety-related radiation monitors are located in the MCRE upstream of the supply air isolation valves. As described in DCD Tier 2, Section 9.4.1.2.3.1, these monitors initiate operation of the non-safety-related supplemental air filtration units when there are "high" gaseous radioactivity concentrations and they isolate the MCR from the VBS when "high-high" particulate or iodine radioactivity concentrations occur.

In DCD Tier 2, Section 9.4.12, the applicant states that the COL applicant will describe the MCR/TSC HVAC subsystem's recirculation mode during emergencies involving toxic substances, and explain how the subsystem equipment isolates and operates, as applicable, consistent with the issues regarding toxic substances that the COL applicant will address, as discussed in DCD Tier 2, Section 6.4.7. This is COL Action Item 6.4-3, as discussed in Section 6.4 of this report.

Portions of the VBS that provide the defense-in-depth (DID) function of filtration of MCR/TSC air during conditions of abnormal airborne radioactivity are designed, constructed, and tested to conform with GSIs B-36 and B-66, RG 1.140, and ASME N-509 and N-510 standards. The MCR/TSC HVAC subsystem has system redundancy, and it is automatically transferred to the onsite non-safety-related DGs if a LOOP occurs. The VBS is located in the auxiliary building with its equipment in separate fire areas and high enough in the building for protection from flooding. DCD Tier 2, Chapters 17, 16, and 13, address system quality assurance, availability, and administrative controls. The equipment procured will meet manufacturer's standards, and like the other equipment of the nuclear island, it will have protection from defined natural phenomena.

The plant control system controls the VBS, except for the MCRE isolation valves, which are controlled by the protection and safety monitoring system. Chapter 7 of this report discusses the plant control and plant safety and monitoring systems. For the DID VBS supplemental air filtration units, DCD Tier 2, Section 9.4.1.5, discusses the instrumentation to satisfy Table 4-2 of ASME N-509-1989. Radioactivity indication and alarms inform the MCR operators of gaseous, particulate, and iodine radioactivity concentrations in the MCR supply air duct. In DCD Tier 2, Section 11.5, the applicant describes the MCR supply air duct radiation monitors and their actuation functions. Smoke monitors are provided to detect smoke in the outside air intake duct to the MCR and the MCR and Class 1E electrical room return air ducts. Temperature indications and alarms are provided in the return air ducts control the room air temperatures within the predetermined range. Temperature indications and alarms for the MCR return air, Class 1E electrical return room air, AHU supply air, supplemental filtration unit prefilter inlet air, and charcoal adsorbers are provided to inform plant operators of abnormal temperature conditions. Pressure differential indications and alarms are provided to control the MCR and monitor the TSC ambient pressure differentials with respect to the surrounding areas. Airflow indication and alarms are provided to monitor operation of the supply and exhaust fans.

9.4.1.1 Main Control Room/Technical Support Center HVAC Subsystem

As shown in DCD Tier 2, Figure 6.4-1, the MCR/TSC subsystem serves the MCRE which consists of the main control area, shift supervisor office, tagging room, toilet (area), clerk room, kitchen/operator area, hallway, and double door vestibule. The MCR/TSC subsystem also serves the TSC, consisting of the main TSC operating area, conference rooms, NRC room, computer rooms, shift turnover room, kitchen/rest area, and restrooms. The MCR and TSC toilets each have a separate exhaust fan.

The MCR/TSC subsystem consists of redundant 100-percent capacity supply AHUs, supplemental air filtration units, return/exhaust air fans, associated dampers, I&C, and common ducts for the MCR and TSC. Each supply AHU consists of a mixing box section, supply air fan, a low-efficiency filter bank, a high-efficiency filter bank, an electric heating coil, chilled water cooling coil bank, and a humidifier. Air-cooled chillers in the VWS normally supply the chilled water.

The supply AHUs and return/exhaust air fans connect to a common duct that distributes air to the MCR/TSC HVAC subsystem. The only HVAC penetrations in the MCRE are MCR supply, return, and toilet exhaust ducts. These penetrations include redundant, safety-related seismic Category I isolation valves that are physically located in the MCRE. The isolation valves isolate the non-safety-related portions of the subsystem from the MCRE when the VES is operating.

The normal outside makeup air enters the subsystem through an outside air intake duct protected by a nonseismic Category I intake enclosure. The applicant states that the nonseismic Category I enclosure is acceptable because failure of the VBS air intake enclosure will not affect the safety-related operation of the VES, including the initial pressure assumptions required by the VES to maintain control room habitability during a design-basis LOCA. The A and C Class 1E electrical room HVAC subsystem shares the outside supply air intake enclosure for the MCR/TSC HVAC subsystem. The staff agrees with the applicant’s justification for a nonseismic Category I intake enclosure.

Temperature sensors located in the MCR return air duct control the tempered air through each AHU to maintain the ambient air design temperature within its normal design temperature range by modulating electric heating or chilled water cooling coil.

Each supplemental air filtration unit includes a high-efficiency filter bank, an electric heating coil, a charcoal adsorber with an upstream and downstream HEPA filter bank, and a fan. Both redundant trains of the supplemental filtration units and one train of the supply AHU are located in the MCR mechanical equipment room at Elevation 135'-3" of the auxiliary building. The other supply AHU is located in the MCR mechanical equipment room at Elevation 135’-3" of the annex building. The MCR toilet exhaust fan is located at Elevation 135’-3" of the auxiliary building. The filtration unit’s housings, located outside the MCRE, are designed to meet the performance requirements of ASME/ANSI AG-1-1997 and Addenda AG-1a-2000, ASME N-509 and N-510 standards. They operate at a negative pressure.

In DCD Tier 2, Table 9.4.1-1, the applicant showed that the depth of the activated charcoal adsorber is 102 mm (4 in.), with an adsorber efficiency of 90 percent and a HEPA filter efficiency of 99 percent. In addition, DCD Tier 2, Table 9.4.1-1 shows a maximum MCRE in-leakage of 177 standard cubic meters per hour (scmh) (110 standard cubic feet per minute (scfm)) [including in-leakages of 16 scmh (10 scfm) through MCR access doors, 16 scmh (10 scfm) through TSC access doors, and 145 scmh (90 scfm) through MCR/TSC HVAC equipment and ductwork (operating)]. In a revision to the DCD, the applicant stated that the testing for MCR/TSC in-leakage during MCR/TSC HVAC subsytem operation will be conducted in accordance with ASTM E741, 2000. The staff finds the applicant’s commitment acceptable for the VBS testing for these in-leakages. The MCR/TSC HVAC equipment ductwork, which forms an extension of the MCR/TSC pressure boundary, limits the overall infiltration (negative operating pressure) and exfiltration (positive operating pressure) rates to those values shown in DCD Tier 2, Table 9.4.1-1, to maintain operator doses within the allowable GDC 19 limits, as applied to the AP1000 design.

During normal operation, one of the two 100-percent capacity supply AHUs and supply/exhaust air fans operate continuously. Outside makeup air to supply AHUs enters through an air intake duct. The outside airflow rate is automatically controlled to maintain the MCR/TSC areas at a slightly positive pressure with respect to the surrounding areas and outside environment. The standby AHU and its corresponding return/exhaust fans start automatically if (1) the operating fan airflow drops below predetermined setpoints, (2) return air temperature rises above or drops below predetermined setpoints, (3) differential pressure between the MCR and the surrounding areas and outside environment is above or below predetermined setpoints, or (4) the operating unit loses electrical and/or control power.

The applicant described the design and operation of the MCR/TSC HVAC subsystem in DCD Tier 2, Section 9.4.1.2.3.1. During abnormal plant operation with high gaseous radioactivity detected in the MCR supply air duct, the system is designed to maintain control room operator doses within the dose acceptance criteria of GDC 19, as applied to the AP1000 design. When monitors detect high gaseous radioactivity in the MCR supply air duct and the MCR/TSC HVAC subsystem is operable, both supplemental air filtration units automatically start to pressurize the MCR/TSC areas to at least 0.03 kPa (1/8" water gauge) using filtered makeup. Operators then manually shut down one of the supplemental filtration units. The normal outside air makeup duct and the MCR and TSC toilet exhaust duct isolation valves close. If open, the smoke/purge isolation dampers close. The subsystem AHU continues to provide cooling, in the recirculation mode, by maintaining the MCRE passive heat sink below its initial ambient air design temperature and maintaining the MCR/TSC areas within their design temperature. The supplemental filtration pressurizes the combined volume of the MCR and TSC concurrently with filtered air. A portion of the recirculated air (approximately 1.89 m^3/sec (4000 cfm)) from the MCR and TSC is also filtered for cleanup of airborne radioactivity.

During abnormal operation, if ac power is unavailable for more than 10 minutes or “high-high” particulate or iodine radioactivity is detected in the MCR supply air duct (which would lead to operator dose limits in excess of the requirements of GDC 19, as applied to the AP1000 design), the plant safety monitoring system automatically isolates the MCRE from the normal MCR/TSC HVAC subsystem by closing the supply, return, and toilet exhaust isolation valves. The VES safety-related supply isolation valve in each train opens automatically to protect the MCR occupants from a potential radiation release, because the radiation monitors are effective only when air is flowing through the VBS ductwork. Section 6.4 of this report discusses the emergency mode of operation.

The staff performed independent radiological consequence analyses for personnel in the MCR and TSC following all AP1000 design basis accidents. This was to verify Westinghouse's assertion that, with ac power available, the VBS can maintain control room and TSC doses within 0.05 Sv (5 rem) TEDE. Staff's review of the applicant's analysis of control room habitability and the staff's independent confirmatory radiological consequence analyses for the control room operators are discussed in Chapter 15.3 of this report. The staff finds that the system design, as bounded by the control room atmospheric relative concentrations proposed by Westinghouse, is capable of controlling radioactivity following design basis accidents to maintain dose to personnel in the MCR and TSC within 0.05 Sv (5 rem) TEDE, when ac power is available for the duration of the accident.

The VBS is not designed as a post-accident engineered safety-feature atmospheric cleanup system and has no safety grade source of power. Therefore, it was not credited in evaluating conformance with GDC 19 as applied to the AP1000 main control room design. Chapter 6.4 of this report includes the staff's evaluation of the MCR emergency habitability system (VES) and AP1000 conformance to GDC 19.

The MCR/TSC subsystem complies with GDC 60, as it relates to protecting those who access the control room during accidental radioactive releases, by initiating the supplemental filtration subsystem. The MCR/TSC subsystem conforms with RG 1.140, Revision 2, regarding detection of high radioactivity or isolating the MCRE and initiating the VES when the redundant nuclear safety-related radiation monitors detect "high-high" airborne radioactivity. The ventilation supply and return/exhaust air ducts in the MCR and TSC areas can be manually isolated from the MCR.

An alarm in the MCR warns if a high concentration of smoke is detected in the outside air intake. The MCR/TSC subsystem is then manually realigned to the recirculation mode by closing the outside air and toilet exhaust duct isolation dampers. The MCR and TSC toilet/kitchen exhaust fans are tripped when the isolation valves close. During the recirculation mode, the MCR/TSC areas are not pressurized. The MCR/TSC subsystem continues to provide cooling and ventilation to maintain the emergency passive heat sink below its initial ambient air design temperature and the MCR/TSC areas within their design temperature.

In the event of a fire in the MCR/TSC, the fire/smoke dampers close automatically to isolate the fire area, while the MCR/TSC subsystem maintains the unaffected areas at a slight positive pressure. The MCR/TSC subsystem continues to provide ventilation and cooling to the unaffected areas to maintain them at a slight positive pressure. The MCR/TSC subsystem can be realigned manually to the once-through ventilation mode to supply 100-percent outside air to the unaffected areas.

The plant ac electrical system supplies power to the subsystem. In the event of a LOOP when the plant ac electrical system is unavailable, the subsystem is automatically transferred to the onsite standby DGs.

In the event that complete ac power is lost and the outside air is acceptable (on the basis of compliance with the requirements of GDC 19), one of the two MCR ancillary fans operate to supply outside air to the MCRE and thus maintain MCRE habitability. DCD Tier 2, Section 9.4.1.2.3.1, describes the outside air supply pathways to the ancillary fans and warm air vent pathways. Power to the ancillary fans is from the respective Division B or C regulating transformers, which receive power from the ancillary DGs. The ancillary fans' flow paths are located within the auxiliary building, which is a seismic Category I structure. Once normal ventilation is restored, the ancillary fan circuits are disabled manually. The applicant states that the ancillary fans are of the centrifugal type with nonoverloading horsepower characteristics; the fans conform to ANSI/AMCA 210, 211, and 300 standards; and each fan can provide a minimum of 0.722 m^3/sec (1530 cfm). The capacity and airflow rate maintain the MCRE environment near the daily average outdoor air temperature. As discussed in Section 22.5.7 of this report, short-term administrative controls for the MCR ancillary fans are part of the regulatory treatment of non-safety systems (RTNSS) process.

9.4.1.2 Class 1E Electrical Room HVAC Subsystem

The Class 1E electrical room (ER) HVAC subsystem has two ventilation trains. One train serves the A and C electrical divisions, spare battery rooms (non-Class 1E), Class 1E spare battery rooms, and reactor pump trip switchgear rooms; the other train serves the B and D electrical divisions and the remote shutdown workstation area.

Each subsystem consists of two 100-percent capacity AHUs, return/smoke exhaust air fans, associated dampers, I&C, and common ductwork. The AHUs and return/exhaust fans connect to a common duct that distributes supply air to the Class 1E electrical rooms. Each supply AHU consists of a mixing box section, supply air fan, a low-efficiency filter bank, a high-efficiency filter bank, an electric heating coil, and chilled water cooling coil bank. Air-cooled chillers in the VWS normally supply the chilled water. In addition, the Class 1E battery rooms have duct-mounted electric heating coils and two 100-percent capacity exhaust fans. The HVAC equipment serving the A and C electrical divisions is located in the MCR A and C equipment rooms at Elevation 135'-3" of the auxiliary building. The HVAC equipment serving the B and D electrical divisions is located in the upper and lower B and D equipment rooms at Elevation 117'-0" and Elevation 135'-3" of the auxiliary building.

During normal operation, one of the redundant supply AHUs, return fans, and battery room exhaust fans operates continuously to maintain acceptable environmental conditions, maintain the Class 1E electrical room emergency passive heat sink below its initial ambient air temperature, and prevent hydrogen gas buildup in the Class 1E battery rooms. The battery exhaust is vented directly to the turbine building vent to limit the hydrogen gas concentration to less than 2 percent by volume, in accordance with RG 1.128, Revision 1, "Installation Design and Installation of Large Lead Storage Batteries for Nuclear Power Plants."

The normal outside makeup air enters the subsystem through an outside air intake duct protected by an intake enclosure. The A and C Class 1E ER HVAC subsystem and the MCR/TSC HVAC subsystem share a common outside supply air intake, located on the roof of the auxiliary building at Elevation 153'-0". The outside supply air intake for the B and D Class 1E ER HVAC subsystem is located separately from the MCR/TSC HVAC subsystem air intake enclosure on the roof of the auxiliary building at Elevation 153'-0".

Temperature sensors located in the return air duct control the tempered air through each AHU. The tempered air maintains the room air temperature within the normal design range by modulating electric heating or the chilled water cooling coil. The standby supply AHU, and corresponding return/smoke exhaust fans, start automatically if the operating fan airflow drops below a predetermined set point, the return air temperature rises above or drops below predetermined setpoints, or the operating unit loses electrical and/or control power.

Abnormal events resulting in detectable airborne radioactivity in the MCR supply air duct of the MCR/TSC HVAC subsystem do not affect the operation of the Class 1E ER HVAC subsystem. During a design-basis accident (DBA), if both onsite and offsite power are lost, the Class 1E ER emergency passive heat sink will provide area temperature control, as discussed in Section 6.4 of this report.

An alarm in the MCR warns if a high concentration of smoke is detected in the air intake. The Class 1E ER HVAC subsystem is then manually realigned to the recirculation mode of operation by closing the outside air intake damper to the AHU mixing plenum, allowing 100-percent room air to return to the supply air subsystem AHU. During the recirculation mode of operation, the subsystem continues to maintain the served areas within their design temperatures and pressures.

In the event of a fire in a Class 1E ER, fire/smoke dampers close automatically to isolate the fire area, and the ER HVAC system maintains the unaffected areas at a slight positive pressure. One or both trains of the subsystem can be manually realigned to the once-through ventilation mode to provide 100-percent outside air to the unaffected areas.

Realignment to the once-through ventilation mode minimizes the potential for migration of smoke and hot gases from a non-Class 1E ER (or a non-Class 1E ER of one division into the Class 1E ER of another division). Reopening the closed combination fire/smoke dampers from outside of the affected fire area during the once-through ventilation mode can remove smoke and hot gases from the affected areas. In the once-through ventilation mode, the outside air intake damper (to the AHU mixing plenum) opens and the return air damper (to the supply AHU) closes to allow 100-percent outside air to the supply AHU. The subsystem exhaust air isolation damper also opens to exhaust room air directly to the turbine building vent.

The plant ac electrical system supplies power to the subsystem. If a LOOP occurs and the plant's ac electrical system is unavailable, the subsystem is automatically transferred to the onsite standby DGs.

When complete ac power is lost, Division B and C MCR ancillary fans operate to supply outside air to the I&C rooms and maintain I&C room temperature. DCD Tier 2, Section 9.4.1.2.3.2, describes the outside air supply pathways to the ancillary fans and warm air vent pathways. Division B or C regulating transformers, which receive power from the ancillary DGs, supply power to the ancillary fans. The ancillary fans' flow path is located within the auxiliary building, which is a seismic Category I structure. Once normal ventilation is restored, the ancillary fan circuits are disabled manually. As discussed in Section 22.5.7 of this report, short-term administrative controls for the MCR ancillary fans are part of the RTNSS process.

9.4.1.3 Passive Containment Cooling System Valve Room Heating and Ventilating Subsystem

The PCS valve room heating and ventilation subsystem consists of one 100-percent capacity exhaust fan, two 100-percent capacity electric unit heaters, and associated dampers, instrumentation, and controls. The subsystem equipment is located in the PCS valve room in the containment dome area at Elevation 286’-6".

During normal operation, the exhaust fan draws outside air through an intake louver damper and directly exhausts it to the environment to maintain room temperature within its normal design temperature range. The lead electric unit heater starts or stops when the room air temperature rises above or drops below predetermined setpoints. The standby electric unit heater starts automatically if the airflow temperature of the operating electric unit heater drops below a predetermined setpoint.

The plant ac electrical system powers the exhaust fan and electric heaters. In the event of a LOOP, the power source is automatically transferred to the onsite standby DGs for the electric unit heaters. Following a fire in the PCS valve room, portable exhaust fans and flexible ductwork can remove smoke and hot gases from the area.

9.4.1.4 Conclusions

The VBS is located inside seismic Category I (auxiliary building) and seismic Category II (annex building) structures, which provide flood and tornado-missile protection. The safety-related MCR isolation dampers are seismic Category I, as shown in DCD Tier 2, Table 3.2-1. Therefore, the system’s safety-related portions comply with the guidelines of Regulatory Position C.1 of RG 1.29. The system’s non-safety-related portions comply with Regulatory Position C.2 of RG 1.29 because the tornado damper installed at the outside air intake and the MCR fire dampers meet seismic Category II requirements, so that the failure of system components during an SSE will not reduce the functioning of any safety-related plant features. System equipment and ductwork located in the nuclear island, the failure of which could affect the operability of safety-related systems or components, are designed to seismic Category II requirements. The remaining portions of the system are nonseismic. Therefore, the system complies with GDC 2 requirements, as they relate to protection of the system against natural phenomena.

Redundant safety-related components of the MCR/TSC HVAC subsystem are physically separated and are protected from internally-generated missiles, pipe breaks, and water spray. All safety-related components are seismic Category I and designed to function following an SSE. The system maintains its function even with the loss of any single active component. In Sections 3.4.1, 3.5.1.1, 3.5.2, and 3.6.1 of this report, the staff documents its evaluation of the design to protect against floods, internally and externally-generated missiles, and high- and moderate-energy pipe breaks. On the basis that the MCR/TSC HVAC subsystem is designed to accommodate and be compatible with environmental conditions and consider dynamic effects, the staff concludes that the control room habitability systems satisfy GDC 4, as it relates to protecting the system against floods, internally-generated missiles, and piping failures.

As stated in Section 9.4 of this report, the HVAC design described in the DCD does not share SSCs with other nuclear power units. Therefore, the VBS meets the requirements of GDC 5.

COL applicants referencing the AP1000 design will identify the toxic gases to be monitored. Section 6.4 of this report discusses the specifics relating to compliance with GDC 19, as it pertains to protection of the control room against intrusion of toxic gases. As stated in that section, the COL applicant can demonstrate compliance with GDC 19 in this regard by complying with the guidance of RG 1.78, Revision 1. Since the guidance of RG 1.78, Revision 1, is site dependent, compliance is the responsibility of the COL applicant. Section 6.4 of this report also discusses compliance with GDC 19, as it relates to radiation dose limits for the control room operator.

The VBS is a nonradioactive HVAC system that serves areas where no radioactive sources are anticipated. Therefore, GDC 60 is not applicable.

As a result of the RTNSS process, short-term administrative controls apply to the MCR ancillary fans that provide long-term cooling to the MCR and I&C rooms in the event of a total loss of ac power.

On the basis of this review, the staff concludes that the VBS complies with GDC 2, 4, 5, 19, and 60, as referenced in Section 9.4.1 of the SRP, and consequently with the subject SRP acceptance criteria.

9.4.2 Annex/Auxiliary Buildings Nonradioactive HVAC System

The staff reviewed the VXS in accordance with the SRP Section 9.4.3, “Auxiliary and Radwaste Area Ventilation System.” Conformance with the SRP acceptance criteria forms the basis for concluding whether the VXS satisfies the following requirements:

- GDC 2, regarding the capability to withstand earthquakes
- GDC 5, regarding sharing systems and components important to safety
- GDC 60, regarding the capability of the system to suitably control release of gaseous radioactive effluents to the environment

The VXS is a nonradioactive HVAC system that serves the nonradioactive personnel and equipment areas; the electrical equipment rooms, clean corridors, ancillary DG room, and demineralized water deoxygenating room in the annex building; and the MSIV compartments, reactor trip switchgear rooms, and piping and electrical penetration areas in the auxiliary building.

Because the VXS is not required to support any functions or operation of any equipment or systems listed in Regulatory Position C.1 of RG 1.29, this guideline is not applicable to the VXS. Additionally, the portions of the VXS located in areas containing safety-related components will be seismically supported in accordance with Regulatory Position C.2 of RG 1.29. Therefore, the VXS conforms with GDC 2, “Design-Basis Protection Against Natural Phenomena.”

DCD Tier 2, Section 9.4.2, Tables 9.4.2-1 through 9.4.2-7, and Figure 9.4.2-1, respectively, provide the system description, design parameters, and piping and instrumentation drawings (P&IDs). In DCD Tier 2, Table 3.2-3, the applicant provides the classification of the VXS system and components. Table 9.4-1 of this report describes the industry standards applicable to the components of the VXS. The VXS supply airflow is balanced in accordance with the guidelines of SMACNA-1983, “HVAC Systems—Testing, Adjusting, and Balancing.”

The VXS is designed to maintain proper operating temperatures in the following areas on the basis of the site interface parameters for maximum and minimum normal temperature conditions defined in DCD Tier 2, Table 2-1. The following summarizes these values:

- for the annex building:
  - offices, corridors, locker rooms, toilet rooms, central alarm stations, and security areas between 22.8 °C to 25.6 °C (73 °F to 78 °F)
  - non-Class 1E battery rooms between 15.6 °C to 32.2 °C (60 °F to 90 °F)
  - switchgear and battery charger rooms, HVAC and mechanical equipment room, and ancillary DG room between 10 °C to 40.6 °C (50 °F to 105 °F)
  - switchgear rooms, battery charger rooms, and ancillary DG room during upset conditions (LOOP), with DGs operating, maximum temperature of 50 °C (122 °F)
- for the auxiliary building:
  - MSIV compartments, non-safety electrical penetration rooms, reactor trip switchgear rooms, and valve/piping penetration room between 10 °C to 40.6 °C (50 °F to 105 °F)
  - demineralized water deoxygenating room, elevator machine room, and boric acid batching room between 10 °C to 40.6 °C (50 °F to 105 °F)

The VXS protects against the buildup of hydrogen concentrations to less than 2 percent in the non-Class 1E battery rooms in the annex building.

DCD Tier 2, Section 7.3, describes the VXS instrumentation. The plant control system (PLS) controls the VXS. The temperature controllers maintain the proper air temperatures and provide indication and alarms that are accessible locally via the PLS. Temperature is indicated for each AHU supply air discharge duct, except for local recirculation units such as those in the MSIV compartments and valve/piping penetration room.

The VXS has the following six independent subsystems, as shown on DCD Tier 2, Figure 9.4.2-1:

- general area HVAC subsystem
- switchgear HVAC subsystem
- equipment room HVAC subsystem

- MSIV compartment heating and cooling subsystem
- mechanical equipment areas HVAC subsystem
- valve and piping penetration room HVAC subsystems

The following sections discuss these subsystems.

9.4.2.1 General Area HVAC Subsystem

The general area HVAC subsystem serves personnel areas in the annex building outside the security area, which include the men's and women's change rooms, shower/toilet areas, the ALARA briefing room, and operational support center, offices, and corridors. The subsystem is not credited for plant abnormal conditions.

This subsystem consists of two 50-percent capacity supply AHUs (8200 scmh each (5100 scfm each)), a humidifier, a ducted supply and return air system, diffusers and registers, and exhaust fans, as well as associated dampers, instrumentation, and controls. The subsystem AHUs are located on the low roof of the annex building at Elevation 117'-6". During normal operation, both AHUs and the toilet/shower exhaust fan operate continuously to keep the served areas within the design temperature range.

Each AHU of the general area HVAC subsystem consists of a centrifugal supply air fan, low-efficiency filter bank, high-efficiency filter bank, a hot water heating coil with integral face/bypass damper, and a chilled water cooling coil. The units discharge into a ducted supply distribution system, which is routed through the building to provide air to the various rooms and areas served via registers. Temperature controllers, with their sensors located in the annex building main entrance, control the AHUs. The temperature controllers modulate the chilled water control valves and the face and bypass dampers of the hot water heating coil in the AHUs and automatically control the switchover between cooling and heating modes. The VWS provides chilled water, and the VYS provides hot water. Outdoor makeup air is added at the AHU to replace air exhausted from the toilet and shower facilities in the annex building. A common steam humidifier is located in the ductwork downstream of the AHUs to provide a minimum space RH of 35 percent; the humidistat control is located in the main entrance of the annex building. The men's and women's locker rooms and the toilet and shower facilities in the annex building have an exhaust fan that exhausts directly to the outside environment.

An electric heating coil tempers the supply air inside the men's and women's facilities. A temperature controller, with a sensor located in the women's facility, controls the heating coil elements.

During replacement of the AHU filters, the affected supply fan is stopped, and subsystem isolation dampers isolate it from the duct system. The toilet/shower exhaust fan is also stopped. During filter replacement mode, the subsystem runs at 50-percent capacity and maintains the served areas in the annex building at a slight positive pressure.

9.4.2.2 Switchgear HVAC Subsystem

This subsystem serves the electrical switchgear rooms in the annex building. The subsystem consists of two 100-percent capacity AHUs, a ducted supply and return air system, and automatic controls and accessories. During normal plant operation, one AHU operates continuously to keep the served areas within the design temperature. The AHU has a temperature controller to maintain the tempered air supply at 16.7 °C (62 °F) dependent on the outdoor ambient temperature conditions.

Each subsystem AHU consists of a centrifugal return/exhaust fan, return/exhaust air plenum, low-efficiency filter bank, high-efficiency filter bank, a hot water heating coil with integral face and bypass dampers, a chilled water cooling coil, and centrifugal supply fan. The AHUs discharge into a common duct supply distribution system, which is routed through the building to the various areas served. The air then returns to the AHU. The VWS and VYS provide chilled and hot water, respectively. The AHUs are located in the north air handling equipment room in the annex building at Elevation 135’-3". The AHUs connect to a common plenum (which also supplies the outdoor air to the equipment room HVAC subsystem) located along the east wall adjacent to the air handling equipment room.

When the outdoor air temperature is above 16.7 °C (62 °F), the outdoor air, return air, and exhaust air dampers automatically reposition to provide minimum outdoor air, and the temperature controller modulates the chilled water control valves to maintain the supply air at 16.7 °C (62 °F). When the outside air temperature is below 16.7 °C (62 °F), each temperature controller modulates the outdoor air, return air, and exhaust air dampers to control a mixture of the return and minimum outdoor air in the proper proportion and modulates the face and bypass dampers of the hot water heating coils to maintain a mixed air temperature of 16.7 °C (62 °F).

During replacement of the AHU filters, the affected supply fan is stopped, and subsystem isolation filters isolate the affected AHU from the duct system. During filter replacement mode, the second AHU of the subsystem runs at full system capacity.

In its once-through smoke exhaust ventilation mode, this subsystem can remove smoke after a fire. Additionally, the alternate subsystem, which consists of 100-percent capacity supply and exhaust propeller fans (mounted in the annex building wall) and controls, provides cooling to electrical switchgear rooms 1 and 2 if the primary subsystem AHUs are unavailable because of a fire. The switchgear rooms will be kept at or below 50 °C (122 °F). The operator will control the fans to keep the area above freezing.

In the event of a LOOP, the supply and return/exhaust fans are connected to the standby power system to provide the DID cooling function to the diesel bus switchgear. In this mode, outdoor air and return air volume dampers are positioned to the once-through flow mode to maintain the switchgear rooms at or below 50 °C (122 °F), where equipment is designed for continuous operation under this environment. To maintain the areas above freezing, the mixing dampers will modulate to maintain a supply air temperature of 16.7 °C (62 °F) for outdoor temperatures below 16.7 °C (62 °F). For outdoor temperatures above 16.7 °C (62 °F), the outdoor air, return air, and exhaust air dampers are positioned for a once-through flow.

9.4.2.3 Equipment Room HVAC Subsystem

This subsystem serves the electrical and mechanical equipment rooms in the annex and auxiliary buildings. These rooms include non-Class 1E battery charger rooms 1 and 2, non-Class 1E battery rooms 1 and 2, non-Class 1E penetration room on Elevation 100’-0" and non-Class 1E penetration room on Elevation 117’-6", and reactor trip switch gear rooms 1 and

2. This system also serves the security area offices and central alarm stations in the annex building (including restrooms, access areas, and corridors).

This subsystem consists of two 100-percent capacity AHUs, two battery room exhaust fans, a toilet exhaust fan, a ducted supply and return air system, and automatic controls and accessories. During normal plant operation, one AHU operates continuously to keep the served areas within the design temperature. The AHU has a temperature controller to maintain the tempered air supply at 16.7 °C (62 °F). Each subsystem AHU consists of a centrifugal return/exhaust fan, return/exhaust air plenum, low-efficiency filter bank, high-efficiency filter bank, a hot water heating coil with integral face and bypass, a chilled water cooling coil, and centrifugal supply fan.

The AHUs discharge into a common duct supply distribution system, which is routed through the building to the various areas served. The air is then returned to the AHU, except for the battery rooms and restrooms. The VWS and VYS provide chilled and hot water, respectively. The AHUs are located in the north air handling equipment room in the annex building at Elevation 135’-3". They connect to a common plenum, which also supplies the outdoor air to the switchgear room HVAC subsystem, located along the east wall adjacent to the air handling equipment room.

When the outdoor air temperature is above 16.7 °C (62 °F), the outdoor air, return air, and exhaust air dampers automatically reposition to provide minimum outdoor air, and the temperature controller modulates the chilled water control valves to maintain the supply air at 16.7 °C (62 °F). When the outside air temperature is below 16.7 °C (62 °F), each temperature controller modulates the outdoor air, return air, and exhaust air dampers to control a mixture of the return and minimum outdoor air in the proper proportion. The face and bypass dampers of the hot water heating coils are also modulated to maintain a mixed air temperature of 16.7 °C (62 °F).

The electrical reheat coils are installed in the ductwork of non-Class 1E battery rooms, security area offices, and central alarm stations. The hot water unit heaters are in the north air handling equipment room and operate intermittently to keep the area above 10 °C (50 °F). A steam humidifier installed in the security areas ductwork provides a minimum RH of 35 percent.

A temperature controller opens the outdoor intake for the elevator machine room and starts and stops the elevator machine room exhaust fan, as required, to maintain the elevator machine room at design temperature conditions. A local thermostat controls the electric unit heater in the elevator machine room.

Each non-Class 1E battery room exhaust system consists of an exhaust fan, gravity backdraft damper, and associated ductwork located in the fan discharge, and exhausts to the atmosphere to prevent a hydrogen gas buildup above 2 percent. Air supplied to the battery rooms by the AHUs is exhausted to the atmosphere. A separate exhaust fan exhausts air from the restroom to the atmosphere.

During replacement of the AHU filters, the affected supply fan is stopped, and subsystem isolation dampers isolate the affected AHU from the duct system. During filter replacement mode, the second AHU of the subsystem runs at full system capacity.

Auxiliary Systems

The portion of the subsystem servicing the auxiliary building is designed so that smoke, hot gases, and fire suppressant will not migrate from one fire area to another, to the extent that they could adversely affect safe-shutdown capabilities, including operator actions. Fire dampers or combination fire and smoke dampers, which close in response to smoke detector signals or in response to the heat from a fire, isolate each fire area from adjacent fire areas during and following a fire, in accordance with NFPA 90A requirements.

In the event of a LOOP, the supply and return/exhaust fans are connected to the standby power system to provide the DID cooling function to the dc switchgear and inverters. In this mode, outdoor air and return air volume dampers are positioned for the once-through flow mode to keep the dc switchgear and inverter areas at or below 50 °C (122 °F). The equipment is designed for continuous operation under this environment. To maintain the areas above freezing, the mixing dampers will modulate to maintain a supply air temperature of 16.7 °C (62 °F) for outdoor temperature below 16.7 °C (62 °F). For outdoor temperatures above 16.7 °C (62 °F), the outdoor air, return air, and exhaust air dampers are positioned for a once-through flow.

9.4.2.4 Main Steam Isolation Valve HVAC Subsystem

The MSIV HVAC subsystem serves the two MSIV compartments in the auxiliary building that contain the main steam and feedwater piping. The main steam and feedwater lines between the turbine building and containment are routed through two separate compartments in the auxiliary building. This subsystem is not credited for plant abnormal conditions.

The MSIV HVAC subsystem consists of two 100-percent capacity AHUs in each compartment (5300 scmh each (3300 scfm each)), supply and air distribution ducting, and automatic controls and accessories. During normal plant operation, one of the AHUs in each compartment operates continuously in a recirculation mode to maintain the design temperature range in the area served by the system.

Each AHU consists of a low-efficiency filter bank, a hot water heating coil, a chilled water cooling coil, a centrifugal supply air fan, and associated I&C. The VWS and VYS provide chilled and hot water, respectively. Each compartment has two inside air temperature indicators. The air temperature controller automatically handles the switchover between cooling and heating modes.

A temperature controller that modulates the chilled water and hot water control valves serving each unit maintains the temperature of the MSIV compartment at or less than 40.6 °C (105 °F) and above a minimum of 10 °C (50 °F). For investment protection, the standby power system can power the subsystem in the event of a LOOP.

The AHU may be shut down for replacement while another AHU in the same MSIV compartment operates to keep the served area within the design temperature range. The AHUs can be connected to the standby power system during a LOOP event for investment protection.

9.4.2.5 Mechanical Equipment Areas HVAC Subsystem

The mechanical equipment areas HVAC subsystem serves the ancillary DG room, the demineralized deoxygenating room, boric acid batching room, and upper and lower south air handling equipment rooms in the auxiliary building. This subsystem maintains the served areas at a slightly positive pressure with respect to the adjacent buildings by supplying a constant volume of outside air. This subsystem is not credited for plant abnormal conditions.

The mechanical equipment areas HVAC subsystem consists of two 50-percent capacity AHUs with supply fans and return/exhaust fans (3538 scmh each (2200 scfm each)), a ducted supply and return air system, and automatic controls and accessories. During normal plant operation, the AHUs operate continuously to maintain the served areas within design temperature range. During replacement of the AHU filters, the affected AHU is stopped, and subsystem isolation dampers isolate it from the duct system. During filter replacement mode, the subsystem operates at approximately 50-percent capacity.

Each subsystem AHU consists of a return/exhaust fan, return/exhaust air plenum, low-efficiency filter bank, high-efficiency filter bank, hot water heating coil with integral face/bypass damper, chilled water cooling coil, centrifugal fan, and associated I&C. The VWS and VYS provide chilled and hot water, respectively. The AHUs are located in the lower south air handling equipment room on Elevation 135’-3" of the annex building. The outdoor air enters from the nontornado-missile-protected air intake plenum #2, which also serves the VAS, VHS, and VFS, and is located at the extreme south end of the annex building between Elevations 135’-3" and 158’-0".

The air temperature indicators are inside the lower south air handling equipment room. Temperature controllers with sensors located in the upper south air handling equipment room maintain the temperature of the area. The temperature controllers modulate the chilled water control valves, and the face and bypass dampers of the hot water heating coil in the AHUs, to keep the areas served by the subsystem within the design temperature range. The area temperature controller automatically controls the switchover between cooling and heating modes.

This subsystem also serves the ancillary DG room and maintains it within the design temperature range when the ancillary DGs are not in operation. A separate exhaust fan dispels the air in the DG room to the outdoors. The exhaust fan for the ancillary DG room operates continuously for room ventilation. The AHUs supply air to the ancillary DG room to maintain normal temperatures. Manually operating dampers and opening room doors to allow radiator discharge air to be exhausted directly to the outside provide ventilation and cooling for the ancillary DGs.

9.4.2.6 Valve and Piping Penetration Room HVAC Subsystem

The valve and piping penetration room HVAC subsystem consists of local recirculation HVAC units to cool the valve/piping penetration room located at Elevation 100’-0" of the auxiliary building. The subsystem is not credited for plant abnormal conditions.

The valve/piping penetration room HVAC subsystem consists of two 100-percent capacity AHUs and has an automatic ducted supply (2894 scmh each (1800 scfm each)) and return air system, as well as automatic controls and accessories. The AHUs are located directly within the space served on Elevation 100’-0". During normal operation, one AHU operates continuously in a recirculation mode to maintain the served area within the design temperature range.

Each AHU in the subsystem consists of a low-efficiency filter, a hot water heating coil, a chilled water cooling coil, centrifugal supply air fan, and associated I&C. The VWS provides chilled water, and the VYS provides hot. Two inside air temperature indicators are provided for each valve and piping penetration room HVAC subsystem. The area temperature controller automatically handles the switchover between cooling and heating modes.

The temperature controllers, with sensors located in the room, modulate the chilled water control valves and the hot water control valves in the operating AHU to maintain the temperature of the valve/piping penetration room at or less than 40.6 °C (105 °F) and above a minimum of 10 °C (50 °F).

Local thermostats control the hot water and electric unit heaters. The area temperature indication is accessible from the MCR. The pressure indication and high differential pressure alarm are provided for each of the filters in the AHUs for filter replacement. The operational status of fans is indicated in the MCR, and the automatic dampers have position-indicating lights. The airflow is indicated for the discharge ducts of the AHUs, and the fan discharge ducts have alarms for low flow rates. The discharge ducts of the AHUs have smoke alarms.

9.4.2.7 Conclusions

Because the VXS is non-safety-related, Regulatory Position C.1 of RG 1.29 does not apply. Additionally, the portions of the VXS located in areas containing safety-related components will be seismically supported in accordance with Regulatory Position C.2 of RG 1.29. System equipment and ductwork located in the nuclear island, the failure of which could affect the operability of safety-related systems or components, are designed to seismic Category II requirements. The remaining portions of the system are nonseismic. Therefore, the VXS conforms to the requirements of GDC 2.

As stated in Section 9.4 of this report, the HVAC design described in the DCD does not share SSCs with other nuclear power units. Therefore, the VXS meets the requirements of GDC 5.

The VXS is a nonradioactive HVAC system that serves areas where no radioactive sources are anticipated. Therefore, GDC 60 is not applicable.

The staff evaluated the VXS for conformance with GDC 2, 5, and 60, as referenced in Section 9.4.3 of the SRP, and concludes that the design of the VXS is acceptable.

9.4.3 Radiologically Controlled Area Ventilation System

The staff reviewed the VAS in accordance with SRP Sections 9.4.2, “Spent Fuel Pool Area Ventilation System,” and 9.4.3, “Auxiliary and Radwaste Area Ventilation System.” Conformance with the SRP acceptance criteria forms the basis for concluding whether the VAS satisfies the following requirements:

- GDC 2, regarding the capability to withstand earthquakes

- GDC 5, regarding sharing systems and components important to safety

- GDC 60, regarding the capability of the system to suitably control release of gaseous radioactive effluents to the environment

- GDC 61, regarding the capability of the system to provide appropriate containment, confinement, and filtering to limit releases of airborne radioactivity to the environment from the fuel storage facility under normal and postulated accident conditions

The VAS neither serves nor supports the plant safety-related functions; therefore, the system has no nuclear safety design basis. The VAS consists of the following two subsystems:

- the auxiliary/annex building ventilation subsystem (AABVS)
- the fuel-handling area ventilation subsystem (FHAVS)

The VAS serves the fuel-handling area of the auxiliary building and the radiologically controlled portions of the auxiliary and annex buildings. The VAS maintains environmental conditions appropriate for equipment operation, for performing maintenance and testing, and for allowing personnel access. The VAS ventilation airflow rate dilutes potential airborne contamination to within the effluent concentration limits allowed by 10 CFR Part 20 at the site boundary during normal plant operation. The plant's internal airborne concentration levels will be within the 10 CFR Part 20 occupational derived air concentration limits.

The VAS maintains normal airflow direction from lower to higher potential airborne concentrations for ALARA considerations. The design of the VAS exhaust subsystems conforms with the requirements of Appendix I to 10 CFR Part 50 for releases during normal operation. Upon detection of high airborne radioactivity in the air exhaust duct or high ambient pressure differential (resulting from an imbalance in supply and exhaust airflow rates), the system isolates unfiltered normal VAS exhaust. In addition, the VFS filtered exhaust subsystem starts to filter the exhaust air from the fuel-handling area (as well as the auxiliary and annex buildings) to minimize unfiltered offsite releases. These areas are maintained at a slight negative pressure with respect to the adjacent clean areas when high airborne radioactivity is detected. The VFS mitigates exfiltration of unfiltered airborne radioactivity by maintaining the isolated zone at a slightly negative pressure with respect to the outside environment and adjacent unaffected plant areas. The VFS maintains a slightly negative pressure differential with respect to the outside environment until operation of the auxiliary/annex building ventilation subsystem (AABVS) and fuel-handling area ventilation subsystem (FHAVS) is restored.

The configuration of the AABVS supply and exhaust ducts results in two independently isolatable building zones. A radiation monitor is located in the exhaust duct, upstream of an isolation damper, in each zone served by the AABVS. The FHAVS supply and exhaust ductwork is arranged to exhaust the SFP plume and to provide directional airflow from the rail car bay/filter storage area into the spent fuel resin equipment rooms. The FHAVS contains a radiation monitor that is mounted upstream of an isolation damper in the exhaust duct. Unfiltered, but monitored, exhaust from the AABVS and the FHAVS is routed to the plant vent during normal operation. However, if high radioactivity is detected, the subsystems' exhaust is filtered through the VFS and then routed to the plant vent. Section 11.5 of this report discusses the staff’s review of radiation monitoring. In conjunction with the VFS as described above, the VAS provides appropriate containment, confinement, and filtering to limit releases of airborne radioactivity to the environment from the fuel storage facility during normal and postulated accident (non-DBA) conditions, in accordance with GDC 61. However, these features receive no credit in the determination of the radiological consequences of a fuel-handling accident (FHA). Chapter 15 of this report discusses the radiological consequences of an FHA.

Each radwaste effluent holdup tank exhaust connects to the AABVS exhaust ducting to prevent the potential buildup of airborne radioactivity or hydrogen gas that may leak within the tanks. The exhaust is then routed to the plant vent through the VFS. The AABVS provides sufficient ventilation to the gaseous radwaste equipment areas to dilute hydrogen gas that may leak from the radwaste equipment into the equipment rooms. The hydrogen gas concentration is kept below a safe level (of about 1 percent) which conforms with the guidelines of SRP Section 11.3. DCD Tier 2, Table 11.3-2 describes the hydrogen monitoring instrumentation. Section 11.3 of this report provides an evaluation of the gaseous waste management system.

DCD Tier 2, Section 9.4.3, Tables 3.2-3 and 9.4.3-1, and Figure 9.4.3-1, respectively, give the VAS description, component design parameters, and piping and instrumentation drawings (P&IDs). Table 9.4-1 of this report describes the industry standards applicable to the components of the VAS. The VAS supply airflow is balanced in accordance with the guidelines of SMACNA-1993, “HVAC Systems—Testing, Adjusting, and Balancing.”

The VAS is a once-through design that draws outdoor air and exhausts the air to the plant vent. During normal plant operation, VAS supply AHUs and exhaust fans for both the AABVS and FHAVS operate continuously to ventilate the areas on a once-through basis. The VAS AHUs automatically shut down if airflow or supply air temperature is below a predetermined setpoint. Temperature controllers maintain proper supply air temperature to maintain the ambient room temperature within the normal range. Temperature sensors in the supply air duct control the temperature of the air supplied by each AHU of the AABVS and FHAVS. When the outdoor air temperature is low, the face and bypass dampers across the supply air heating coil are modulated to maintain the ambient room temperature. When the outdoor air temperature is high, the chilled water coil tempers the supply air. The VWS provides chilled water for the VAS and the VYS supplies hot.

The VAS cooling and heating capacity depends on the site interface parameters for maximum and minimum normal temperature conditions, as defined in DCD Tier 2, Table 2-1. The annex building staging areas and storage areas, as well as other corridors and staging areas, are maintained between 10 °C and 40 °C (50 °F and 104 °F). The corridors and access areas served by the FHAVS are maintained between 10 °C and 40 °C (50 °F and 104 °F). The AABVS serves the radiation chemistry laboratory and security rooms and maintains them between 22.8 °C and 25.6 °C (73 °F and 78 °F). The AABVS also serves the primary sample room and maintains it between 10 °C and 40 °C (50 °F and 104 °F).

DCD Tier 2, Section 7.3, describes the VAS instrumentation. The PLS controls the VAS. The temperature controllers maintain the proper air temperatures and provide indications and alarms. The pressure differential indications and alarms monitor the outside air and inside ambient pressures of the fuel-handling area and auxiliary/annex buildings and control the supply airflow to maintain a slightly negative pressure differential with respect to adjacent clean areas and outdoors. Operators can view the area temperature indication from the MCR for the

RNS and makeup pump rooms without accessing these rooms. Auxiliary building and fuel-handling area radiation monitoring instrumentation (radiation detectors) is in the system exhaust ducts upstream of the isolation dampers. As described above, upon detection of high airborne radioactivity in the air exhaust duct or high ambient pressure differential, the unfiltered exhaust air ducts are automatically isolated and the VFS filtered exhaust automatically starts. The MCR is provided with indication and alarms in the exhaust ducts from the fuel-handling area and radiologically controlled areas of the auxiliary and annex buildings. Operational status of fans and dampers is indicated in the MCR. All fans and AHUs can be operated or shut down from the MCR. The system filters and unit coolers have pressure indications and high differential pressure alarms.

During normal operation, smoke monitors located downstream of the AHUs and upstream of the exhaust fans continuously monitor the AABVS and FHAVS ventilation air. The supply AHUs automatically shut down if monitors detect an airflow rate of the fans or air temperature below a predetermined set point.

During abnormal plant operation, if smoke is detected in the supply or exhaust ducts, an alarm is initiated in the MCR. HVAC subsystems remain in operation, but MCR operators may shut down manually if necessary. In the event of a fire within the served areas, local fire dampers automatically isolate the HVAC ductwork penetrating the affected fire area once the local temperature exceeds the predetermined setpoints.

9.4.3.1 Auxiliary/Annex Building Ventilation Subsystem

The configuration of the AABVS supply and exhaust ducts comprise two zones. One zone serves the annex building staging and storage area, containment air filtration rooms, containment access corridor, and adjacent auxiliary building staging area, equipment areas, middle annulus, middle annulus access room, and security rooms. The other zone includes the remaining rooms and corridors shown in Figure 9.4.3-1, sheet 2 of 3, including but not limited to the radiation chemistry laboratory, primary sample room, SFP cooling water pump and heat exchanger rooms, RNS pump and heat exchanger rooms, CVS makeup pump room, lower annulus, and various radwaste equipment rooms, pipe chases, and access corridors. The AABVS provides conditioned air to maintain the following proper operating temperatures in the following areas:

- the residual heat removal and CVSs’ pump rooms (pumps not operating), containment purge exhaust filter rooms (fans not operating), liquid radwaste pump rooms, HVAC equipment room, gaseous equipment rooms, and SFP pump and heat exchanger rooms, between 10 °C and 40 °C (50 °F and 104 °F)

- the degasifier column, RNS and CVS pump rooms (pumps operating), containment purge exhaust filter rooms (fans operating), and liquid radwaste tank rooms between 10 °C and 54.4 °C (50 °F and 130 °F)

The supply air flow rate is modulated to maintain a slightly negative pressure differential with respect to the outside environment. The annex building heating coil provides supplementary heating for the exterior annex/auxiliary building areas. The AABVS consists of two 50-percent capacity supply AHUs (28,944 scmh each (18,000 scfm each)), two 50-percent capacity exhaust fans sized to allow the AABVS to maintain a negative pressure in served areas with respect to the adjacent areas, associated ductwork, dampers, diffusers and registers, and I&C. Each AHU consists of a centrifugal supply air fan, a low-efficiency filter bank, a high-efficiency filter bank, a water heating coil with integral face and bypass dampers, a chilled water cooling coil, and associated I&C. The supply AHUs are located in the south air handling equipment room of the annex building at Elevation 158’-0" and are connected to common air intake plenum #3. The common, nontornado-missile-protected air intake plenum #3 is located at the extreme south end of the annex building between Elevation 158’-0" and about 180’-0". Each subsystem AHU discharges into a ducted supply distribution system, which is routed through the radiologically controlled areas of the auxiliary and annex buildings.

The AABVS exhaust fans are located in the auxiliary building at Elevation 145’-9". The supply and exhaust ducts have isolation dampers. During normal operation, the subsystem’s exhaust is unfiltered and directed to the plant vent for discharge. During high-radiation isolation mode, the normal unfiltered ventilation subsystem is isolated from the affected zone when high airborne radioactivity is detected, and the isolated area is exhausted through the VFS to the monitored plant vent. The VFS exhaust fans prevent unfiltered airborne releases by maintaining these areas at a slight negative pressure with respect to the outside environment and adjacent clean plant areas.

Each CVS makeup and normal RNS pump room has a dedicated, 100-percent capacity unit cooler (for a total of two per CVS and RNS pump room) to provide supplemental cooling during pump operation. Redundant trains of the VWS supply chilled water to the coolers. Each unit cooler consists of a low-efficiency filter bank, a cooling coil bank, and a fan; each RNS pump room cooler alsohas redundant cooling coil banks. Therefore, either redundant train of the VWS can support the operation of both RNS pumps simultaneously. The CVS pump room coolers are connected to redundant trains of the VWS; however, either train unit cooler can maintain the common makeup pump room temperature conditions and support either makeup pump operation. The pump room coolers automatically start whenever the associated pump receives a start signal or a high room temperature signal. In a LOOP event, the onsite DGs can power unit coolers.

A concrete floor section and flexible seals that connect the containment steel shell to the shield building separate the upper annulus from the middle annulus area of the auxiliary building. The annulus seal provides a passive ventilation barrier during normal operation or during isolation of the auxiliary building to prevent the exfiltration of unmonitored releases from the middle annulus to the environment.

Locally installed electric coils and humidifiers supplement the supply air ducts in the radiation chemistry laboratory and security room to maintain environmental conditions comfortable for personnel. The electric unit heaters provide supplemental heating in the middle annulus as shown in DCD Tier 2, Figure 9.4.3-1.

9.4.3.2 Fuel-Handling Area Ventilation Subsystem

The FHAVS serves the fuel-handling area, rail car bay/filter storage area, resin transfer pump/valve room, spent resin tank room, waste disposal container area, solid radwaste system (WSS) (spent resin) valve/piping area, and elevator machine room.

The FHAVS provides air to maintain the following temperatures:

- the rail car bay/filter storage area between 10 °C and 40 °C (50 °F and 104 °F)
- the spent resin equipment rooms between 10 °C and 54.4 °C (50 °F and 130 °F)
- the fuel-handling area between 10 °C and 35.6 °C (50 °F and 96 °F)
- the areas occupied by plant personnel during refueling activities, to a maximum wet bulb temperature of 26.7 °C (80 °F), within the guidelines of Electric Power Research Institute NP-4453

The supply airflow is modulated to maintain the served areas at a slight negative pressure differential with respect to the outside environment. The rail car bay heating coil provides supplementary heating for the rail car bay. The FHAVS consists of two 50-percent capacity supply AHUs (15,276 scmh each (9500 scfm each)), two 50-percent capacity exhaust fans sized to allow the FHAVS to maintain a negative pressure in served areas with respect to the adjacent areas, associated ductwork, dampers, and I&C. Each AHU consists of a centrifugal supply air fan, a low-efficiency filter bank, a high-efficiency filter bank, a water heating coil with integral face and bypass damper, a chilled water cooling coil, and associated I&C. These areas form a single isolation zone when high airborne radioactivity is detected in the exhaust air. The supply AHUs are located in the south air handling equipment room of the annex building at Elevation 135'-3" and connect to common air intake plenum #2. The common, nontornado-missile-protected air intake plenum #2 is located at the south end of the annex building between Elevation 135'-3" and about 158'-0". Each subsystem AHU discharges into a ducted supply distribution system, which is routed to the fuel-handling area and rail car bay/filter storage areas of the auxiliary building.

The FHAVS supply AHUs are located in the south air handling equipment room of the annex building at Elevation 135'-3", and the exhaust fans are located in the upper radiologically controlled area ventilation system equipment room at Elevation 145'-9" of the auxiliary building. The exhaust has isolation dampers. During normal operation, the subsystem’s exhaust is unfiltered and goes to the plant vent for discharge and monitoring of offsite gaseous releases. In high-radiation isolation mode, the normal unfiltered ventilation subsystem is isolated from the affected zone, and the isolated area is exhausted through the VFS to the monitored plant vent.

9.4.3.3 Conclusions

As described in DCD Tier 2, Section 9.4.3 and Table 3.2-3, the VAS is located completely within a seismic Category I auxiliary building and seismic Category II annex building structures, and all system components are non-safety-related. Regulatory Position C.1 of RG 1.29 is not applicable because the FHAVS is not credited with the mitigation of the FHA, and therefore, it is not required to remain functional after an SSE. The evaluation of the FHAVS for interaction with seismic Category I systems discussed in Section 3.7.3 of this report finds that the VAS complies with Regulatory Position C.2 of RG 1.29. The evaluation demonstrates that seismic failure of the FHAVS does not reduce the functioning of the safety-related plant features. System equipment and ductwork located in the nuclear island, the failure of which could affect the operability of safety-related systems or components, are designed to seismic Category II requirements. The remaining portion of the system is nonseismic. Because the AABVS is not credited for any DBA conditions, it is not required to remain functional after an SSE. The makeup pump and RNS pump room coolers and exhaust fans for the AABVS are located in the seismic Category I auxiliary building. Therefore, the VAS complies with the requirements of GDC 2.

As stated previously in Section 9.4 of this report, the HVAC design described in the DCD does not share SSCs with the other nuclear power units. Therefore, the VAS meets the requirements of GDC 5.

As discussed above, the subsystems' unfiltered but monitored exhaust is routed to the plant vent during normal operation. If high radioactivity is detected, the VFS filters the subsystems' exhaust, which is then routed to the plant vent. This procedure complies with the guidelines of RG 1.140 for controlling the release of radioactivity, as discussed in DCD Tier 2, Chapter 1, Appendix 1A. As discussed in Section 9.4.7 of this report, the design, construct, and testing of the VFS filtration units conform to ASME/ANSI AG-1-1997 and Addenda AG-1a-2000, ASME N-509 and N-510 standards, and the guidelines of RG 1.140, Revision 2. Therefore, the VAS also complies with the requirements of GDC 60, as they relate to the capability of the system to suitably control the release of gaseous radioactive effluents to the environment.

The VFS filtration units, which filter the VAS radioactive exhaust, conform to Regulatory Position C.4 of RG 1.13, as discussed in DCD Tier 2, Chapter 1, Appendix 1A. Consequently, the system complies with the requirements of GDC 61, as they relate to the capability of the system to provide appropriate containment, confinement, and filtering to limit releases of airborne radioactivity to the environment.

The staff evaluated the VAS for conformance with GDC 2, 5, 60, and 61, as referenced in SRP Sections 9.4.2 and 9.4.3. As discussed above, the staff found that the VAS meets the requirements of GDC 2, 5, 60, and 61. Therefore, the staff concludes that the VAS design is acceptable.

9.4.4 Balance-of-Plant Interfaces

The AP1000 is a complete design; therefore, balance-of-plant interfaces are not applicable to this design.

9.4.5 Engineered Safety Features Ventilation System

The staff evaluated the non-safety-related HVAC systems against the RTNSS criteria. The staff concludes that none of the HVAC systems are engineered safety feature (ESF) ventilation systems, and that no HVAC system is required to support non-safety-related systems determined to be important by the RTNSS process, on the basis of the following:

- Except for the VES and portions of the VBS, the HVAC systems are not safety-related and are not RTNSS systems. The portions of the VBS that are part of the RTNSS process consist of the short-term administrative controls provided for the MCR ancillary fans (as discussed in Section 22.5.7 of this report). The safety-related VES is credited with meeting the requirements of GDC 19 during a design-basis LOCA. Section 6.4 of this report evaluates the safety-related VES.

- The VBS provides safety-related design-basis functions to (1) monitor the air supply for radioactive particulate and iodine concentrations inside the MCRE, and (2) isolate the safety-related, seismic Category I HVAC piping penetrating the MCRE upon detecting “high-high” particulate or iodine radioactivity in the supplied air. The VBS is non-safety-related except as described above and is not credited with meeting the requirements of GDC 19 during a design-basis LOCA. Section 9.4.1 of this report evaluates the non-safety-related VBS.

- The VFS is not required to mitigate the consequences of a design-basis FHA or a LOCA. The staff evaluated the VFS in accordance with SRP Section 9.4.5, “Engineered Safety Features Ventilation System.” The system serves no safety-related function other than containment isolation, and its operation is not required following a DBA. Section 9.4.7 of this report evaluates the non-safety-related VFS.

- No other non-safety-related HVAC systems are credited in the accident dose analyses or provide any safety-related design-basis functions. Sections 9.4.2, 9.4.3, 9.4.6, and 9.4.8 through 9.4.11 of this report evaluates other HVAC systems.

9.4.6 Containment Recirculation Cooling System

The staff reviewed the VCS in accordance with SRP Section 9.4.5. Conformance with the SRP acceptance criteria forms the basis for determining whether the VCS satisfies the following requirements:

- GDC 2, regarding the capability to withstand earthquakes

- GDC 4, regarding maintaining environmental conditions in essential areas compatible with the design limits of the essential equipment located in those areas during normal, transient, and accident conditions

- GDC 5, regarding sharing systems and components important to safety

- GDC 17, “Electric Power System,” regarding the assurance of proper functioning of essential electric power systems

- GDC 60, regarding the capability to suitably control release of gaseous radioactive effluents to the environment

The VCS is a non-safety-related ventilation system that is not required to mitigate the consequences of a DBA or LOCA. If the VCS is available following abnormal operational transients, fan coil units can operate at slow speed for postevent recovery operations to lower the containment temperature and pressure. A maintenance space ventilation subsystem with a portable exhaust filtration unit supplements the VCS. Used during shutdown and refueling operation, this subsystem protects maintenance personnel and controls the spread of airborne contamination from the steam generator compartments to the other containment areas. During integrated leak rate testing (ILRT) operation, the VCS fans are operated at slow speed in order not to exceed their rated horsepower, which could affect the ILRT results.

The VCS operates during normal plant operation and shutdown to maintain suitable temperatures in the served areas of the containment building. The two fan coil unit (FCU) assemblies are located on a platform at Elevation 153’-0", approximately 180 degrees apart to provide proper mixing of return and supply air. The top of the ring header is at Elevation 176’-6". System equipment and ductwork located in the nuclear island, the failure of which could affect the operability of safety-related systems or components, are designed to seismic Category II requirements. The remaining portion of the system is nonseismic.

DCD Tier 2, Section 9.4.6, Table 9.4.6-1, and Figure 9.4.6-1, provides the system description, component design parameters, and P&ID. Table 9.4-1 of this report describes the industry standards applicable to the components of the VCS. The VCS airflow is balanced in accordance with SMACNA-1993, “HVAC Systems—Testing, Adjusting, and Balancing.”

The VCS maintains temperatures in the served areas below 48.9 °C (120 °F) during normal operation. The VCS also maintains the reactor cavity area average concrete temperature at 65.6 °C (150 °F), with a local area temperature of 93.3 °C (200 °F). During refueling and plant shutdown, the bulk air temperature of the served areas is maintained below 21.1 °C (70 °F) and above 10 °C (50 °F) for personnel access and equipment operability.

As stated in DCD Tier 2, Section 9.4.6.2 and Table 9.4.6-1, and as shown in DCD Tier 2, Figure 9.4.6-1, the VCS has two 100-percent FCU assemblies, each with two separate, but physically connected, 50-percent capacity FCUs. Each FCU assembly draws air from the upper levels of the operating floor and delivers tempered air through the ring header and the secondary duct distribution system to the cubicles, compartments, and access areas above and below the operating floor, including the reactor cavity and reactor support areas. As the tempered air absorbs the heat released from the various components inside containment, return air rises through vertical passages and openings where it is again returned to the FCUs, tempered, dehumidified, and recirculated.

Each FCU assembly consists of two 50-percent capacity FCUs. Each FCU contains a vane axial, upblast, direct-driven fan with a two-speed motor; return air mixing plenum section with a physical barrier in the middle; and three chilled water cooling coils attached to the side of each plenum section. The fans operate on high speed during normal operation and low speed for high ambient air density conditions, such as during ILRT and abnormal post-event recovery operation.

The VWS supplies the chilled water and the VYS provides the hot. The cross-connections for VWS and VYS are located outside containment. The water piping inside containment is common to both the VWS and VYS.

To meet the environmental design criteria during various modes of VCS operation, temperature controllers in the ring headers of the corresponding FCU provide an input signal to modulate the VWS supply valves to the cooling coils to maintain the normal air supply at 15.6 °C (60 °F). The standby FCUs start automatically if the discharge flow rate from the operating FCU drops below a predetermined setpoint, if the discharge temperature from the operating FCU rises above or drops below a predetermined setpoint, and if the system loses electrical and/or control power. The FCU fans are connected to 480-V buses with backup power supply from the onsite standby DGs.

A steam generator maintenance space ventilation subsystem is employed through the compartment supply air ducts during reactor shutdown for personnel access and maintenance activities. This vacuum system protects personnel and controls the spread of airborne radioactive contamination from the steam generator compartments to the other containment areas. The subsystem consists of permanently installed exhaust ductwork with flexible hose connections in the vicinity of steam generator channel heads, which can connect to a portable exhaust filtration unit (which does not exhaust outside of containment). During subsystem operation, closing relevant supply dampers will isolate the supply air distribution ductwork.

DCD Tier 2, Section 7.3 describes the VCS instrumentation. The VCS is monitored by the plant monitoring system and controlled by the plant control system. The indication of the operational status and controls for the equipment inside the containment are provided in the MCR. Temperature indications and alarms provided in the equipment compartment or areas of the containment maintain the supply air temperature within a predetermined range.

Monitoring of the containment and equipment compartment temperatures occurs from the MCR. The FCU discharge flow is monitored, and a low-flow alarm alerts the MCR operator to start the spare FCU manually. The reactor cavity areas are also monitored and alarmed for low-flow condition.

Regulatory Position C.1 of RG 1.29 does not apply to the VCS because the system is not designed to perform any safety functions. Instead, the VCS complies with Regulatory Position C.2 of RG 1.29 for the following reasons:

- System equipment and ductwork located in the nuclear island, the failure of which could affect the operability of safety-related systems or components are designed to seismic Category II requirements. The remaining portions of the system are nonseismic.

- DCD Tier 2, Section 3.7.3.13, evaluates the VCS for interaction with seismic Category I systems to ensure that the VCS does not reduce the functioning of any safety-related plant features. Section 3.7.3 of this report evaluates seismic interaction.

The staff finds this meets Regulatory Position C2 of RG 1.29 and is acceptable. Therefore, the system complies with the requirements of GDC 2.

As stated previously in Section 9.4 of this report, the HVAC system design described in the DCD does not share SSCs with other nuclear power units. Therefore, the VCS meets the requirements of GDC 5.

The staff determined that the VCS is not an ESF system, the system is not credited with analyzing the consequences of DBA, and the system does not exhaust to the environment. Therefore, the requirements of GDC 4, 17, and 60 are not applicable.

The staff has evaluated the VCS for conformance with GDC 2, 4, 5, 17 and 60 as referenced in SRP Section 9.4.5 and finds that the VCS meets the applicable GDC. Therefore, the staff concludes that the VCS design is acceptable.

9.4.7 Containment Air Filtration System

The staff reviewed the VFS in accordance with SRP Section 9.4.5. Conformance with the SRP acceptance criteria forms the basis for determining whether the VFS satisfies the following requirements:

- GDC 2, regarding the capability to withstand earthquakes
- GDC 4, regarding maintaining environmental conditions in essential areas compatible with the design limits of the essential equipment located in those areas during normal, transient, and accident conditions
- GDC 5, regarding sharing systems and components important to safety
- GDC 17, regarding the assurance of proper functioning of essential electric power systems
- GDC 60, regarding the capability to suitably control release of gaseous radioactive effluents to the environment
- GDC 61, regarding the capability of the system to provide appropriate containment, confinement, and filtering to limit releases of airborne radioactivity to the environment

The VFS is not required to mitigate the consequences of a design-basis FHA or a LOCA. The system serves no safety-related function other than containment isolation, and its operation is not required following a DBA. The containment isolation components are safety Class B and seismic Category I, and the quality assurance requirements of 10 CFR Part 50, Appendix B are applicable.

The components include air-operated, fail-close (during loss of power or loss of air pressure) containment isolation valves (CIVs), penetrations, interconnecting piping, and vent and test connections with manual valves. The supply and exhaust air lines that penetrate the containment pressure boundary are 914.4 mm (36 in.) in diameter. Each penetration includes inboard and outboard branch connections with 406.4-mm (16-in.)-diameter CIVs that are opened when the VFS is aligned to containment. The other ends of the containment penetrations are capped with 914.4-mm (36-in.)-diameter blind flanges for installation provisions for a high-volume purge system on a site-specific basis.

The seismic Category I debris screens are designed for post-LOCA pressures and mounted on safety Class C, seismic Category I piping between the containment atmosphere and the CIVs. This prevents entrainment of debris through the supply and exhaust opening that may prevent a tight valve shutoff against the containment pressure. The CIVs in the supply and exhaust air subsystems automatically close when they receive a containment isolation signal or a containment area high-radiation signal. The CIVs are designed to shut tightly when subject to the containment pressure following a DBA. Section 6.2.4 of this report evaluates the containment isolation function and finds it acceptable.

The VFS also provides the following functions:

- control of flow of outdoor air for containment purging to reduce the airborne radioactivity to an acceptable level for personnel access intermittently during normal plant operation and continuously during hot or cold plant shutdown conditions

- containment pressure control within its normal design pressure range by intermittent venting of air into and out of the containment

- filtration of exhaust air before discharge to the plant vent in accordance with the guidelines of 10 CFR Part 50, Appendix I for offsite releases and 10 CFR Part 20 allowable effluent concentration limits, when combined with other gaseous effluent releases, for the site boundary release

- monitoring of gaseous, particulate, and iodine concentration levels discharged to the environment through the plant vent

- conditioning and filtration of outside air to provide a comfortable environment for personnel inside the containment during access for maintenance and refueling operations

- filtration of exhaust air from the fuel-handling area, and auxiliary or annex buildings, and maintenance of these areas at a slight negative pressure with respect to the adjacent clean areas through the VFS exhaust air subsystem

The VFS is designed to maintain the supply air temperature range between 10 °C and 21.1 °C (50 °F and 70 °F) inside containment, depending on maximum and minimum normal outside temperature conditions shown in DCD Tier 2, Table 2-1. The VCS distributes and conditions the supply air within the containment.

The VFS supply air subsystem airflow is measured and balanced in accordance with SMACNA-1993. The VFS containment isolation valves, which are located in the auxiliary and containment buildings, conform to ASME Section III, Class 3, for Class B valves and B31.1 for Class D valves.

The non-safety-related portions of the VFS are designed to accomplish their intended functions assuming a single active failure and a LOOP event. The VFS consists of two 100-percent capacity, 1.9 m^3/s (4000 cfm) supply and exhaust air subsystems. Each train consists of a supply AHU, ducted air supply, registers, valves and piping, automatic controls, and accessories. Each of the exhaust air systems consists of filtration units, exhaust fans, valves and piping, automatic controls, and accessories. Exhaust air subsystems also contain common containment isolation valves and piping prior to the inlet of the air filtration units and common exhaust leading to the plant vent. A gaseous radiation monitor, located downstream of the exhaust air filtration units in the common ductwork, activates an alarm in the MCR when the monitor detects excess activity in the effluent discharge. The plant vent exhaust flow is monitored for gaseous, particulate, and iodine releases to the environment. Section 11.5 of this report describes the radiation monitoring system.

The supply AHUs are located in the south air handling equipment room of the annex building at Elevation 158’-0". The exhaust filtration units are located within the radiologically controlled portion of the annex building at Elevation 135’-3" and Elevation 146’-3". The common air intake plenum #3 for the supply and makeup air for the exhaust fan (which is not protected from turbine missiles) is located at the extreme south end of the annex building between Elevation 158’-0" and Elevation 180’-0". The ductwork located inside containment, the potential failure of which could affect safety-related equipment, is designed to seismic Category II requirements. DCD Tier 2, Section 9.4.7, Tables 3.2-3, 9.4-1, and 9.4.7-1, and Figure 9.4.7-1, respectively, provide the VFS description, P&IDs, and component design parameters. Table 9.4-1 of this report describes the industry standards applicable to the components of the VFS.

Each supply AHU consists of a low-efficiency filter, a high-efficiency filter, a hot water heating coil with integral face and bypass dampers, a chilled water cooling coil, a supply air fan, and associated I&C. Modulating the supply fan inlet vanes to compensate for filter loading or changes in containment pressure controls the AHU airflow rate to a constant value. Temperature sensors located in the supply air duct control the discharged air through each AHU. When the supply air temperature is low, the integral face and bypass dampers across the hot water heating coil bank are modulated to heat the supply air. When the supply air temperature is high, the chilled water flow is modulated to maintain the desired temperature in the area. A smoke alarm located in the common discharge ductwork downstream of the AHUs continuously monitors the supply air.

Each exhaust air filtration unit consists of a 100-percent capacity electric heater to maintain 70 percent or less RH of the effluent air, an upstream high-efficiency filter bank, a charcoal adsorber with pre- and post-HEPA filter bank, an exhaust fan, and I&C. The postfilters downstream of the charcoal adsorbers have a DOP efficiency of 95 percent and conform to UL-900-1994, “Test Performance of Air Filter Units.” The isolation dampers in the exhaust air subsystem are bubble-tight, single-blade or parallel-blade type, and conform to Air Movement and Control Association (AMCA) 500, “Testing Methods for Louvers, Dampers, and Shutters,” and ASME AG-1-1997 and Addenda AG-1a-2000.

The representative samples of charcoal adsorbent are tested to verify a minimum charcoal efficiency of 90 percent, in accordance with the guidance of RG 1.140, Revision 2, at frequencies identified in the ASME N-510-1989 standard. Each HEPA filter cell is individually shop tested to verify an efficiency of at least 99.97 percent in accordance with ASME AG-1-1997. The exhaust air subsystem filtration units are designed, constructed and tested to conform with ASME AG-1-1997, ASME N-509-1989 and N-510-1989 standards, and the guidelines of RG 1.140, Revision 2.

Each charcoal adsorber is a single-tray assembly with welded construction and a 101.6-mm (4-in.) thickness Type III rechargeable adsorber cell, which conforms with IE Bulletin 80-03.

The air flow rate through the exhaust filters is controlled to a constant value when the exhaust filters are connected to the containment. Modulating the exhaust fan inlet vanes to compensate for filter loading or changes in system resistance caused by single or parallel fan operation, or a change in containment pressure, achieves this control. The containment exhaust line consists of isolation valves arranged in parallel, to restrict the airflow to maintain the exhaust plenum at a negative air pressure when the containment is positively pressurized. This prevents the exfiltration of unfiltered air bypassing the filtration unit filters.

During normal plant operation, one supply AHU provides outdoor air, which is filtered, cooled or heated, to the containment areas above the operating floor. During single subsystem operation, the operator can manually start the standby supply and exhaust air units if the operating train fails. The VWS supplies the chilled water, and the VYS supplies the hot. One exhaust fan discharges the filtered exhaust air from the containment to the atmosphere through the plant vent.

Before and during cold plant shutdown, one or both trains of the VFS can be operated to remove airborne radioactivity before personnel enter the containment. When both trains operate concurrently, the VFS provides a maximum air flow rate equivalent to 0.21 air changes per hour.

During an abnormal operation, if monitors detect high airborne radioactivity or pressure differential in the fuel-handling area, or the auxiliary or annex buildings (zone areas), the VAS is isolated from the served zone area(s), and the VFS exhaust air subsystem operates to maintain the isolated zone(s) at a slightly negative pressure with respect to adjacent clean areas. Differential pressure control dampers modulate the exhaust airflow rate to provide outside makeup air to the exhaust fan when the VFS exhaust air subsystem is connected to the VAS-served zone area(s). The VFS is automatically isolated from the containment if purging is in progress and the standby exhaust filtration train does not start. One VFS train can be manually aligned to continue containment purging while the other VFS train is aligned to exhaust effluent from the zone areas. If both exhaust filtration trains are connected to containment, one exhaust filtration train is automatically isolated from the containment and is realigned to the zone area(s). The VFS exhaust air subsystem can be manually connected to the DGs during a LOOP. The VFS is not credited for a design-basis FHA or a LOCA, but it may be used if it is operational and onsite power is available to support postevent recovery operations.

DCD Tier 2, Section 7.3 describes the VFS instrumentation. The plant control system controls the VFS, except for the CIVs, which the protection and safety monitoring system (PMS) and diverse actuation system (DAS) control. DCD Tier 2, Section 9.4.1.5, discusses the instrumentation to satisfy Table 4-2 of ASME N-509-1989 for the VFS air filtration units. The status indication and alarms monitor fans, control dampers, and control valves. Operators can remotely start all fans and AHUs or shut them down from the MCR or locally. The temperature controllers maintain the proper supply air temperature.

Operators can locally access the temperature indication and alarms for high or low supply air temperature via the plant control system and be alerted to abnormal temperature conditions for supply air and charcoal adsorbers. The flow indication and alarms are provided for equipment malfunctions. The radioactivity indication and alarms are provided in the MCR for the gaseous radioactivity in the filtration subsystem’s common exhaust duct and gaseous and particulate and iodine concentrations in the plant vent. Monitors detect the pressure drops across all AHUs and exhaust air filtration unit filters (except charcoal filters), and a high-pressure drop generates an alarm in the MCR.

Sections 3.5, 3.6, and 6.2.4 of this report discuss the protection of the safety-related portions (containment isolation) of the VFS against internally and externally-generated missiles, as well as against high- and moderate-energy pipe breaks.

The staff concludes that the system's safety-related portions comply with the guidelines of Regulatory Position C.1 of RG 1.29, and the system's non-safety-related portions comply with Regulatory Position C.2 of RG 1.29, because of the following VFS design features:

- location inside seismic Category I (containment and auxiliary building), flood-protected, and tornado-missile-protected buildings

- classification of the safety-related containment isolation valves, penetrations, interconnecting piping, debris screens, and vent and test connections as seismic Category I as shown in DCD Tier 2, Table 3.2-3

System equipment and ductwork located in the nuclear island, the failure of which could affect the operability of safety-related systems or components, are designed to seismic Category II requirements to preclude them from collapsing onto safety-related equipment or structures during a SSE. The remaining portion of the system is nonseismic. In Section 3.12.3.7 of this report, the staff evaluates the VFS for interaction with seismic Category I systems and verifies that its failure does not reduce the ability of any safety-related plant features to perform their functions. Therefore, the staff finds that the system complies with the requirements of GDC 2.

The staff determined that the system is not an ESF system and that it is not credited in analyzing the consequences of a DBA, except for containment isolation. Therefore, the requirements of GDC 4 and 17 are not applicable to this system.

As stated previously in Section 9.4 of this report, the HVAC design described in the DCD does not share SSCs with other nuclear power units. Therefore, the VFS meets the requirements of GDC 5.

The filtered VFS exhaust is monitored and then routed to the plant vent in compliance with the guidelines of RG 1.140, Revision 2 for controlling the release of radioactivity. Therefore, the system complies with the requirements of GDC 60, as the relate to the system's capability to suitably control the release of gaseous radioactive effluents to the environment. The VFS filtration units, which also filter the VAS radioactive exhaust, meet the guidance of Regulatory Position C.4 of RG 1.13, which specifies that the SFP building be equipped with an appropriate ventilation and filtering system to limit the potential release of radioactive iodine and other radioactive materials. Therefore, the system complies with the requirements of GDC 61, as they relate to the system capability to provide appropriate containment, confinement, and filtering to limit releases of airborne radioactivity to the environment.

The staff has evaluated the VFS for conformance with GDC 2, 4, 5, 17, 60, and 61, as referenced in SRP Section 9.4.5, and concludes that the VFS meets the applicable GDC. Therefore, the staff concludes that the VFS design is acceptable.

9.4.8 Radwaste Building HVAC System

The staff reviewed the VRS in accordance with SRP Section 9.4.3. Conformance with the SRP acceptance criteria forms the basis for determining whether the VRS satisfies the following requirements:

- GDC 2, regarding the capability to withstand earthquakes
- GDC 5, regarding sharing systems and components important to safety
- GDC 60, regarding the capability to suitably control release of gaseous radioactive effluents to the environment

The VRS serves the radwaste building, which includes the clean electrical/mechanical equipment room, potentially contaminated HVAC equipment room, package waste storage room, waste accumulation room, and mobile system facility. The VRS is located within the radwaste building, except for the portion that connects with the plant vent. The VRS is a non-seismic system and has no safety-related functions. The VRS is a once-through, non-safety-related ventilation system that operates at 100-percent capacity continuously, with both supply air handling units and both exhaust fans running during normal plant operation to maintain suitable temperatures in the radwaste building. During filter replacement operations, the VRS operates at 50-percent capacity, and radwaste processing operations are adjusted to obtain an acceptable temperature in the radwaste building. The location of the supply air system AHUs is in the electrical/mechanical equipment room at Elevation 100'-0" on the southwest side of the radwaste building. The exhaust air system fans are located in the HVAC equipment room at Elevation 100'-0" in the northwest corner of the radwaste building.

The VRS collects the vented discharges from potentially contaminated equipment and provides for radiation monitoring of exhaust air before its release to the environment through the plant vent stack. Section 11.5 of this report describes the radiation monitoring system.

DCD Tier 2, Section 9.4.8, Figure 9.4.8-1, and Table 3.2-3 provide the system description and components classification. As identified in DCD Tier 2, Table 3.2-3, the VRS components are non-nuclear safety class, nonseismic category, and the quality assurance requirements of Appendix B to 10 CFR Part 50 do not apply. Table 9.4-1 of this report describes the industry standards applicable to the components of the VRS.

The VRS is designed to maintain the following proper operating temperatures, depending on the maximum and minimum normal outside temperature conditions shown in DCD Tier 2, Table 2-1:

- processing areas and storage rooms control between 10 °C and 40.5 °C (50 °F and 105 °F)
- mechanical and electrical equipment rooms between 10 °C and 40.5 °C (50 °F and 105 °F)

The radwaste building is maintained at a negative pressure with respect to the ambient environment to prevent potentially unmonitored radioactive releases from the radwaste building.

The differential pressure controllers, with sensors located in the general building area and mounted outdoors with shielding from wind effects, automatically modulate the inlet vanes of the AHU supply fans to maintain negative pressure inside the radwaste building with respect to the outdoors. The electric interlocks between the large truck doors and the supply fan flow controller permit the supply air to drop to 2.832 m^3/s (6000 cfm) below the exhaust flow when any truck bay door is open to create a flow into the radwaste building through the open door.

The VRS consists of the supply air system and the exhaust air system. The VRS total flow is 8.495 m^3/s (18,000 cfm), consisting of two 4.248 m^3/s (9000 cfm) trains. The supply air system consists of two 50-percent capacity AHUs, each with a low-efficiency filter bank, a high-efficiency filter bank, hot water heating coil, chilled water coil, and a centrifugal fan with automatic inlet vanes. The VWS supplies chilled water and the VYS supplies hot. Each AHU draws 100 percent outside air through individual louvered outdoor air intakes. The two AHUs discharge into a common air supply duct distribution system that is routed through the radwaste building.

Separate cooling and heating temperature controllers with sensors in the general building area control the temperature of the air supplied by the AHUs. The cooling controllers modulate the control valves on the chilled water supply lines to the AHUs to maintain the desired temperature in the area. The heating controllers modulate the face and bypass dampers of the hot water heating coil in the AHUs to maintain the desired temperature in the area. The hot water unit heaters in the mobile facility, which are controlled by local thermostats, are provided to temper air entering the building when a roll-up door is opened. The hot water unit heater in the electrical/mechanical room operates in response to local thermostats to maintain the minimum required temperature.

The exhaust air system consists of two 50-percent capacity centrifugal fans sized to allow the system to maintain a negative pressure with respect to the adjacent areas, an exhaust air duct collection system, and automatic controls and accessories. The exhaust fans discharge to a common duct, which is routed to the plant vent. A radiation monitor records activity in the common exhaust air system discharge duct and activates an alarm in the MCR when it detects excess activity in the effluent discharge. The exhaust air collection duct inside the radwaste building exhausts air from areas and rooms where low levels of airborne contamination may be present. The exhaust connection points allow the direct exhaust of equipment located on the mobile systems. The backdraft dampers at each mobile system vent connection prevent blowback through the equipment in the event of exhaust system trip. Where potentially high levels of airborne radioactive contamination exist, mobile systems will include HEPA filtration. DCD Tier 2, Sections 11.2 and 11.4 of this report discuss the mobile processing systems.

The PLS controls the VRS, which is designed to permit periodic inspection of system components during normal plant operation (see DCD Tier 2, Section 7.1.1, which discusses the PLS). The temperature is indicated for each AHU supply air discharge duct. Local differential pressure indications and high-pressure alarms the AHU and exhaust air system air filters alert the operator to the need for filter replacement. An alarm warns of high radiation in the main exhaust duct to the vent stack. Airflow indications are provided for the AHU and exhaust fan discharge ducts, and the fan discharge ducts have low-flow alarms. The operational status indications for the fans are displayed in the MCR. From the MCR, operators can initiate or shut down the fans and AHUs. The common AHU discharge duct has an alarm for smoke.

Position-indicating lights are provided for automatic dampers. Chapter 7 of this report describes the VHS instrumentation.

Regulatory Position C.1 of RG 1.29 does not apply because the VRS is not designed to perform any safety-related functions. The VRS complies with Regulatory Position C.2 of RG 1.29 for the following reasons:

- The VRS serves no safety-related function. Failure of the system does not affect the operation of safety-related structures, systems, or components because none of these are located in the area served by the system.

- The system is non-safety-related and is not credited to operate during any abnormal plant conditions.

Therefore, the system complies with the requirements of GDC 2.

As stated previously in Section 9.4 of this report, the HVAC design described in the DCD does not share SSCs with other nuclear power units. Therefore, the VRS meets the requirements of GDC 5.

The VRS collects the vented discharges from potentially contaminated areas and provides for radioactive particulate removal and radiation monitoring of exhaust air before its release to the environment through the plant vent stack. Therefore, the system meets the requirements of GDC 60, as they relate to the system’s capability to suitably control the release of gaseous radioactive effluents to the environment.

The staff has evaluated the VRS for conformance with GDC 2, 5, and 60, as referenced in Section 9.4.3 of the SRP, and concludes that the system meets these GDC. Therefore, the staff concludes that the VRS design is acceptable.

9.4.9 Turbine Building Ventilation System

The staff reviewed the turbine building ventilation system (VTS) in accordance with SRP Section 9.4.4, “Turbine Area Ventilation System.” Conformance with the SRP acceptance criteria forms the basis for determining whether the VTS satisfies the following requirements:

- GDC 2, regarding the capability to withstand earthquakes

- GDC 5, regarding sharing systems and components important to safety

- GDC 60, regarding the capability to suitably control the release of gaseous radioactive effluents to the environment

The VTS operates during startup, shutdown, and normal plant operations. The VTS consists of (1) the general area ventilation subsystem, (2) the electrical equipment and personnel work area HVAC subsystem, and (3) the local area heating and ventilation subsystem. The general area ventilation subsystem serves the operating deck, intermediate levels, and base slabs. The electrical equipment and personnel work area HVAC subsystem serves switchgear rooms 1 and 2, the electrical equipment room, the RCP variable frequency drive (VFD) power converter room, and personnel work areas (secondary sampling laboratory and office spaces at Elevation 117’-6" and Elevation 171’-0") at Elevation 149’-0" and the engineering work station at Elevation 171’-0". The local area heating and ventilation subsystem serves the lube oil reservoir room, clean and dirty lube oil storage room, toilet areas (facilities), auxiliary boiler room, and motor-driven fire pump room. The VTS maintains the air temperature of all areas inside the turbine building between 10 °C and 40.6 °C (50 °F and 105 °F), except for the personnel work areas. These areas are maintained between 22.8 °C and 25.6 °C (73 °F and 78 °F), depending on the maximum and minimum normal outside temperature conditions shown in DCD Tier 2, Table 2-1.

DCD Tier 2, Section 9.4.9, Figure 9.4.9-1, and Table 3.2-3 provide the system description and components classification. As identified in DCD Tier 2, Table 3.2-3, the VTS components are a nonnuclear safety class and nonseismic category. As such, the quality assurance requirements of Appendix B to 10 CFR Part 50 do not apply. Table 9.4-1 of this report describes the industry standards applicable to the HVAC components of the VTS.

The VTS neither serves nor supports the plant’s safety-related functions; therefore, the system need not be designed to meet the guidelines of RGs 1.29 and 1.140 or to withstand the effects of an SSE. Some areas of the turbine building have a potential for radioactive contamination, but any contamination is expected to be low. Radiological monitors are provided in the turbine building to detect system leakage in the condenser air removal, SG blowdown, CCW, and main steam systems. Section 11.5 of this report discusses the radiation monitoring system (RMS).

The VTS is designed to permit periodic inspection of system components during normal plant operation. The VTS is monitored by the plant monitoring system and controlled by the plant control system. Temperature indication is provided to allow temperature surveillance of room and space temperatures in the turbine building. Controllers are provided to control the room air temperatures to within a predetermined range. Differential pressure indication and high-pressure alarms are provided for the AHU air filters.

9.4.9.1 General Area Heating and Ventilation Subsystem

The general area ventilation subsystem serves most of the turbine building and is manually controlled. The subsystem consists of roof-mounted exhaust ventilators and wall-mounted louvers. The ventilators are of the hooded, direct-driven, propeller type with pneumatically actuated backdraft dampers. The wall louvers are located at Elevation 100'-0", Elevation 117'-6", and Elevation 135'-3". During heating operation, the general area ventilation subsystem is not operated. Additionally, the operating floor wall louvers are normally closed during power operation and are manually opened during outage operations for ventilation.

The general area heating subsystem is manually or automatically controlled. The system consists of hot water unit heaters and heater fans, and provides local heating throughout the turbine building. Thermostats in the automatic mode control the system heater fan motors. The VYS supplies the hot water to the subsystem.

9.4.9.2 Electrical Equipment and Personnel Work Area HVAC Subsystem

This HVAC subsystem consists of an independent electrical equipment area HVAC system and an independent personnel work area HVAC system.

The VWS supplies the subsystem with chilled water, while the VYS supplies hot water. The subsystem maintains served areas at a slight positive pressure by mixing outside air with the recirculated air. The subsystem room thermostats control the chilled water control valves for cooling and the integral face/bypass dampers for heating.

Each independent system serving corresponding areas consists of two 50-percent AHUs located at Elevation 149'-0" of the turbine building. Each AHU consists of a mixing box section, high- and low-efficiency filters, an integral face and bypass damper, a hot water heating coil, and a chilled water cooling coil. The electrical equipment area HVAC system consists of two 50-percent capacity AHUs with a supply and return air of about 27,336 scmh (317,000 scfm) each, a ducted supply and return air system, automatic controls, and accessories. The personnel work area HVAC system consists of two 50-percent capacity AHUs with a supply and return air of about 11,457 scmh (7125) scfm each, a ducted supply and return air system, automatic controls, and accessories. Electric reheat coils, provided in the ductwork to each room, are served by the personnel work area HVAC system and maintain close temperature control. During normal operation, all AHUs operate continuously.

9.4.9.3 Local Area Heating and Ventilation Subsystem

The lube oil reservoir room, clean and dirty lube oil storage room, toilet areas (facilities), and secondary sampling laboratory fume hood have centrifugal exhaust fans to remove flammable vapors, odors, or chemical fumes, as required.

A direct-drive, two-speed, wall exhaust ventilator is provided for each of the auxiliary boiler rooms and the motor-driven fire pump room. The ventilators are of the two-speed, propeller type with pneumatically actuated backdraft dampers. The air is pulled from the general area of the turbine building through the fire damper openings and exhausted to the atmosphere. Each exhaust ventilator is automatic or manually controlled. In the automatic mode, the exhaust ventilator motor is controlled by a two-stage room thermostat. In the manual mode, the exhaust fan runs continuously at high speed until it is stopped manually.

The motor-driven fire pump room is heated by the hot water-to-unit heater supplied from the VYS for fire pump freeze protection. The fan motors of the hot water unit heater are controlled by a thermostat during automatic mode; the heater fans run continuously in manual mode.

The auxiliary boiler room does not provide hot water heating. The auxiliary boiler room exhaust fan pulls air from the general area of the turbine building. A heating thermostat is provided in the boiler room to control the operation of the fan when the temperature falls below 10 °C (50 °F). The boiler room exhaust fan starts at low speed and continues to run until the temperature in the space rises above 10 °C (50 °F).

9.4.9.4 Conclusions

Because the VTS is nonseismic and is not designed to perform any safety functions, it is not required to comply with Regulatory Position C.1 of RG 1.29. The VTS does comply with Regulatory Position C.2 of RG 1.29 as follows:

- The VTS serves no safety-related function. Failure of the system does not affect the operation of safety-related structures, systems, or components because none of these are located in the area served by the system.

- The system is non-safety-related and is not credited to operate during any abnormal plant conditions.

Therefore, the system complies with the requirements of GDC 2.

As stated previously in Section 9.4 of this report, the HVAC design described in the DCD does not share SSCs with other nuclear units. Therefore, the VTS meets the requirements of GDC 5.

As stated above, radiological monitoring is provided in the turbine building in the condenser air removal, SG blowdown, CCW, and main steam systems to detect system leakage for any potential radioactive contamination. Section 11.5 of this report discusses the RMS. Temporary barriers are provided around the SG blowdown system (BDS), CCS, and condensate polishing areas for radiological protection. Therefore, the system is in compliance with the requirements of GDC 60.

As described above, the staff evaluated the VTS to determine its conformance with the requirements of GDC 2, 5, and 60, as referenced in SRP Section 9.4.4, and found that the VTS meets these requirements. Therefore, the staff concludes that the VTS design is acceptable.

9.4.10 Diesel Generator Building Heating and Ventilation System

The staff reviewed the DG building heating and ventilation system (VZS) in accordance with SRP Section 9.4.5. Conformance with the SRP acceptance criteria forms the basis for determining whether the VZS satisfies the following requirements:

- GDC 2, regarding the capability to withstand earthquakes

- GDC 4, regarding the compatibility of the environmental conditions in essential areas with the design limits of the essential equipment located therein during normal, transient, and accident conditions

- GDC 5, regarding sharing systems and components important to safety

- GDC 17, regarding the assurance of proper functioning of essential electric power systems

- GDC 60, regarding the capability to suitably control the release of gaseous radioactive effluents to the environment

The VZS serves the standby DG rooms, electric equipment service modules, and diesel fuel oil day tank vaults in the DG building, as well as the two diesel oil transfer modules located in the yard. The VZS consists of the normal heating and ventilation subsystem, the standby exhaust ventilation subsystem, the fuel oil day tank vault exhaust subsystem, and the diesel oil transfer module enclosures ventilation and heating subsystem.

As identified in DCD Tier 2, Table 3.2-3, the VZS components are a nonnuclear safety class and nonseismic category. As such, the quality assurance requirements of Appendix B to 10 CFR Part 50 do not apply. DCD Tier 2, Section 9.4.10 and Figure 9.4.10-1, respectively, provide the system description and layout drawings. Table 9.4-1 of this report describes the industry standards applicable to the HVAC components of the VZS.

The two redundant DGs and associated equipment that provide standby ac power in the event of a LOOP are located in separate rooms of the non-safety-related DG building. Each DG room is served by an independent train of the VZS that provides normal heating and ventilation to continuously maintain acceptable environmental conditions when the DGs are not operating. The standby exhaust ventilation portion of the VZS functions when the corresponding DG is in operation to maintain acceptable temperatures for equipment operation and reliability. This allows for the onsite standby power system to perform its defense-in-depth function. Within each DG room, an electrical equipment service module houses the DG electrical and control support equipment. Each DG has its own dedicated diesel oil transfer module with an enclosure and is located in the yard. The DGs are not safety-related and are not essential for the safe shutdown of the plant. The VZS, which supports the operation of the DGs, is also not safety-related.

The VZS is designed to maintain the temperature inside the DG area between 10 °C (50 °F) and 40.6 °C (105 °F) when the DG is not operating, and a maximum of 54.4 °C (130 °F) when the DG is operating. In DCD Tier 2, Section 8.3.1.1.2.1, the applicant stated that the DGs will be procured to be consistent with the VZS (i.e., with a design requirement of a maximum of 54.4 °C (130 °F) when the DG is operating), as described in DCD Tier 2, Section 9.4.10.

The VZS also maintains the temperature inside the electrical equipment service modules between 10 °C (50 °F) and 40.6 °C (105 °F) at all times. Each dedicated diesel oil transfer module is maintained between 10 °C (50 °F) and 40.6 °C (105 °F) inside an enclosure. Two electric unit heaters are provided in each DG room, which maintain the space at 10 °C (50 °F) when the DGs are not operating. The VZS is designed for ambient conditions of -20.6 °C to 35 °C (-5 °F to 95 °F), which equals the 5 percent exceedance values.

Each train of the normal heating and ventilation subsystem consists of one 100-percent capacity engine room AHU that ventilates the DG room, one 100-percent capacity service module AHU that ventilates the electrical equipment service module, an exhaust system for the DG room, an exhaust system for the fuel oil day tank vault, and two electric unit heaters in the DG area. The engine room AHUs are located above the electrical equipment service module with HVAC ducting into the DG rooms. The service module AHUs are located above the service module with HVAC ducting into the module. Outside air is supplied to each AHU through a wall-mounted fixed louver. Air intake louvers are located as high in the DG building wall as possible, which meets the intent of the guidance of NUREG/CR-0660, “Enhancement of Onsite Emergency Diesel Generator Reliability,” to control the dust and other particulates for conformance with GDC 17, as it relates to ensuring proper functioning of the standby onsite ac electric power system.

Each AHU of the normal heating and ventilation subsystem consists of a mixing box section, a high-efficiency filter bank, a low-efficiency filter bank, and a centrifugal fan. During normal plant operation, the engine room AHU runs continuously when the DG is off and outdoor air is required for room cooling. The space thermostats control the proportion of outside air that is mixed with return air to maintain adequate temperature in the areas served by the engine room. The excess outside air supplied to the engine room is discharged to the outdoors via a gravity relief damper.

Each service module AHU has an electrical heating coil that is controlled by a separate space thermostat. The outside air is supplied to each AHU through a wall-mounted fixed louver. The excess outside air from the service module flows into the diesel engine area via a wall-mounted relief damper. The service module AHU operates continuously regardless of the DG status.

Each train of the standby exhaust ventilation subsystem consists of two 50-percent capacity roof-mounted exhaust fans and two motor-operated air intake dampers mounted in the exterior walls of the room. The exhaust fans turn on when the DGs start and turn off when the DGs stop. The standby exhaust fans are actuated by a DG start signal, as shown in DCD Tier 2, Figures 9.4.10-1 and 9.4.10-2. The motor-operated air intake dampers open and close in conjunction with the operation of the exhaust fans. One or both standby exhaust fans are required to operate to maintain the engine room temperature in reference to ambient temperature. The subsystem is required to operate to support DG operation during a LOOP.

Each fuel oil day tank vault is continuously ventilated by a 100-percent capacity centrifugal exhaust fan. The exhaust fans are roof-mounted and ducted to draw air from 0.3 m (1 ft) above the vault floor to remove any oil fumes generated in the space. Air is drawn into each fuel oil tank vault from the DG room through a fire damper. The fans are manually operated.

The diesel oil transfer module enclosures are serviced by a separate exhaust ventilation system. Each diesel oil transfer module enclosure is ventilated by a 100-percent capacity, roof-mounted exhaust fan. Outside air is drawn into the enclosure through manually operated louvered air intakes; these louvers are closed during winter operation when heating is required. An electric unit heater is provided in each enclosure to maintain the space at a minimum temperature of 10 °C (50 °F). The subsystem is required to operate to support DG operation during a LOOP.

Because the VZS has two 50-percent capacity exhaust fans for each DG room and one 100-percent capacity AHU for each service module, at least one DG train will be fully operational should a single fan failure occur.

The system design allows for periodic inspection of the system's components (see DCD Tier 2, Section 7.1.1, for the plant control system). The system temperature indication and alarms are accessible locally via the plant control system. The operational status indications for the fans are provided in the MCR. All fans and AHUs can be operated locally or from the MCR. The AP1000 design provides for a differential pressure indication for each filter in the AHUs and a high-pressure drop alarm for each AHU.

Because the VZS is not designed to perform any safety functions, it is not required to comply with Regulatory Position C.1 of RG 1.29. However, the VZS does comply with Regulatory Position C.2 of RG 1.29 as follows:

- The VZS serves no safety-related function. Failure of the system does not affect the operation of safety-related structures, systems, or components because none of these are located in the area served by the system.

- The system is non-safety-related and is not credited to operate during any abnormal plant conditions.

Therefore, the system design complies with the requirements of GDC 2.

The VZS is not required to maintain a controlled environment in areas containing safety-related equipment, and areas served by the VZS do not contain equipment essential for the safe shutdown of the reactor or necessary to prevent or mitigate the consequences of a DBA. Therefore, GDC 4 is not applicable to the VZS.

As stated previously in Section 9.4 of this report, the HVAC design described in the DCD does not share SSCs with other nuclear power units. Therefore, the VZS meets the requirements of GDC 5.

The onsite standby power system (ZOS) includes two DGs housed in the non-safety-related DG building. The applicant states that the ZOS and DGs are not safety-related; therefore, they are not essential for the safe shutdown of the reactor, nor are they necessary to prevent or mitigate the consequences of a DBA. The applicant further states that the VZS is physically separated from potentially contaminated areas and does not contain any radioactive materials. Therefore, the VZS is not required to comply with the recommendations of RGs 1.52, “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,” and 1.140, or the requirements of GDC 60.

The staff has evaluated the VZS for conformance with the requirements of GDC 2, 4, 5, 17, and 60, as referenced in SRP Section 9.4.5, and concludes that the VZS meets the applicable GDC. Therefore, the staff concludes that the VZS design is acceptable.

9.4.11 Health Physics and Hot Machine Shop HVAC System

The staff reviewed the VHS in accordance with SRP Section 9.4.3. Conformance with the SRP acceptance criteria forms the basis for determining whether the VHS satisfies the following requirements:

- GDC 2, regarding the capability to withstand earthquakes

- GDC 5, regarding sharing systems and components important to safety

- GDC 60, regarding the capability to suitably control release of gaseous radioactive effluents to the environment

The VHS collects the vented discharges from potentially contaminated sumps and equipment in the health physics area, as well as exhaust from welding booths, grinders, and other equipment located in the hot machine shop. It also monitors exhaust air for radiation before its release to the environment through the plant vent stack. Section 11.5 of this report describes the RMS.

The VHS serves no plant safety-related functions, and there are no safety-related SSCs in the area serviced by the system. The VHS is a once-through, non-safety-related ventilation system that operates only during the normal modes of plant operation. The VHS is located within the annex building, except for the portion of that system that connects with the plant vent. The VHS serves both the health physics/access control area in the annex building located at Elevation 100’-0" and the hot machine shop located at Elevation 107’-2" in the annex building. These areas are maintained at a slight negative pressure with respect to the outdoors and clean areas to ensure that all potentially radioactive releases are monitored before discharge.

The supply air subsystem AHUs are located in the lower south air handling equipment room at Elevation 135’-3" of the annex building. The exhaust air subsystem fans are located in the staging and storage areas at Elevation 135’-3" of the annex building.

As identified in DCD Tier 2, Table 3.2-3, the VHS components are a nonnuclear safety class and nonseismic category. As such, the quality assurance requirements of 10 CFR Part 50, Appendix B do not apply. DCD Tier 2, Section 9.4.11 and Figure 9.4.11-1 present the system description and layout drawings, respectively. Table 9.4-1 of this report describes the industry standards applicable to the HVAC system components of the VHS.

The VHS maintains the direction of air flow from areas of low potential radioactivity to areas of higher potential radioactivity. The VHS is designed to maintain the temperature of the health physics area at 22.8 °C to 25.6 °C (73 °F to 78 °F), and the hot machine shop at 18.3 °C to 29.4 °C (65 °F to 85 °F), depending on the maximum and minimum normal outside temperature conditions shown in DCD Tier 2, Table 2-1. The VHS is designed to maintain a minimum relative humidity of 35 percent in normally occupied areas via a steam humidifier located in the main system supply duct. The water for the system humidifier is provided by the demineralized water system.

The differential pressure controllers, with sensors in the general health physics area and sensors mounted outdoors (shielded from wind effects), modulate the automatic inlet vanes of the supply fan to maintain the area at a negative pressure with respect to the surrounding areas. A separate differential pressure controller, with a sensor in the hot machine shop, modulates a damper in the supply air duct to the hot machine shop to maintain a negative pressure with respect to the outdoors.

The VHS consists of the supply air subsystem and the exhaust air subsystem. The supply air subsystem consists of two 100-percent capacity (22,512 scmh each (14,000 scfm each)) AHUs, each with a low- efficiency filter bank and a high-efficiency filter bank; a hot water heating coil; a chilled water cooling coil bank; a centrifugal fan with automatic inlet vanes, associated dampers, and I&C; and ductwork. Each AHU draws 100 percent outside air through a common louvered outdoor air intake plenum #2, as described in DCD Tier 2, Section 9.4.2. The two AHUs discharge into a distribution system to the health physics and hot machine shop areas. The temperatures in the health physics and hot machine shop areas are maintained within the design range by a temperature sensor located in the health physics area. This sensor modulates the control valve on the chilled water supply lines to the cooling coil and the face and bypass dampers of the hot water heating coil. The supply of the chilled and hot water is provided by the VWS and VYS, respectively.

The exhaust air subsystem consists of two 100-percent capacity centrifugal exhaust fans, sized to maintain a negative pressure with respect to the adjacent areas, with ductwork and automatic controls. A separate machine shop exhaust fan and high-efficiency filter are provided for the machine tools and other localized areas in the hot machine shop. The air flow rates are balanced to maintain a constant exhaust air flow across the fans. The exhaust fans discharge to a common duct, which is routed to the plant vent stack. Individual flexible exhaust duct branches are provided to the machine tools area. The flexible ducts are connected to a hard duct manifold, which is connected to a filter and a fan. The exhaust fan discharges into the main system exhaust ductwork.

Should a single failure occur, one supply AHU and one exhaust fan are capable of maintaining corresponding areas at the designed temperatures, at a slight negative pressure, and with the direction of system air flow from areas of low radioactivity to areas of high radioactivity.

The health physics area, including the hot machine shop, is monitored by a non-safety-related radiation monitor. The radiation monitor is located in the common VHS exhaust duct. High-radiation alarms are provided both locally and in the MCR. DCD Tier 2, Sections 9.4.11 and 11.5 and Tables 11.5-1 and 11.5-2 describe these radiation monitors.

Temperature indication is provided for each AHU supply air discharge duct. Local differential pressure indications and MCR high-pressure alarms are provided for the AHU and exhaust air system air filters. The remote manual hand switches and alarms for the system fans are provided in the MCR. The fans and AHUs can be initiated or shut down from the MCR. An alarm is provided for smoke in the common AHUs discharge duct. Position indicating lights are provided for automatic dampers.

Regulatory Position C.1 of RG 1.29 does not apply because the VHS is not designed to perform any safety functions. However, the VHS does comply with Regulatory Position C.2 of RG 1.29 as follows:

- The VHS serves no safety-related function. Failure of the system does not affect the operation of safety-related structures, systems, or components because none of these are located in the area served by the system.

- The system is non-safety-related and is not credited to operate during any abnormal plant conditions.

Therefore, the system design complies with the requirements of GDC 2.

As stated previously in Section 9.4 of this report, the HVAC design described in the DCD does not share SSCs with other nuclear power units. Therefore, the VHS meets the requirements of GDC 5.

The VHS is not safety-related, performs no safety-related function for safe shutdown or postaccident operation, and failure of the system does not affect the functions of other safety-related equipment. The lower south air handling equipment room in the annex building, where the VHS supply AHUs are located, has no sources of radioactivity during normal plant operation. The hot machine shop mezzanine area, where the hot machine shop exhaust fans are located, is not a high-radioactivity area. The shielding of components and personnel is commensurate with radiation sources in the vicinity of the VHS equipment during normal plant operation.

The VHS collects the vented discharges from potentially contaminated areas and provides for radiation monitoring of exhaust air prior to its release to the environment through the plant vent stack. Therefore, the requirements of GDC 60 are met.

The staff has evaluated the VHS for conformance with GDC 2, 5, and 60, as referenced in SRP Section 9.4.3, and concludes that the VHS meets the requirements of GDC 2, 5, and 60. Therefore, the staff concludes that the VHS design is acceptable.

Table 9.4-1 HVAC System Components

Component	Standard	Title
Supply, return, and exhaust fans	ANSI/AMCA 210-85	Laboratory Methods of Testing Fans for Rating Purposes
	ANSI/AMCA 211-87	Certified Ratings Program Air Performance
	AMCA 300-85	Reverberant Room Method of Testing Fans for Rating Purposes
Housings, ductwork, supports, and accessories	SMACNA-1980	Rectangular Industrial Duct Construction Standards
	SMACNA-1995	HVAC Duct Construction Standards—Metal and Flexible
	SMACNA-1999	Round Industrial Duct Construction Standards
	SMACNA-1985	HVAC Duct Leakage Test Manual
	Addenda AG-1a-2000	Housings
Low-efficiency filters, high-efficiency filters, and post-filters	ANSI/ASHRAE 52.1-1992	Gravimetric and Dust Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter, Standards
	ASHRAE 126, 2000	Method of Testing HVAC Air Ducts
	ASHRAE 62-1999	Ventilation for Acceptable Indoor Air Quality
	UL-900, 1994	Test Performance of Air-Filter Units, Class I Criteria
Cooling coils and hot water heating coils	ANSI/ARI 410-91	Forced-Circulation Air Cooling and Air Heating Coils
	ANSI/ASHRAE 33-1978	Methods of Testing for Rating Forced Circulation Air Cooling and Air Heating Coils
Electric unit heaters	UL-1996, 1996	Electric Duct Heaters
	NFPA 70, 1999	National Electrical Code
Electric heating coils	UL-1095, 1995	Electric Central Air Heating Equipment
Humidifiers	ARI 620-96	Self-Contained Humidifiers, Standards
Dampers, isolation dampers, and containment exhaust air dampers	ANSI/AMCA 500-89	Testing Methods for Louvers, Dampers, and Shutters
	SMACNA-1993	HVAC Systems Testing, Adjusting, and Balancing
	ASME N-509-1989	Nuclear Power Plant Air-Cleaning Units and Components

Component	Standard	Title
HEPA filters and charcoal adsorbers	ASME N-510-1989	Testing Nuclear Air Cleaning Systems
	ASME N-509-1989	Nuclear Power Plant Air-Cleaning Units and Components
	ANSI/ASME AG-1-1997	Code on Nuclear Air and Gas Treatment
	UL-586, 1996	High-Efficiency, Particular, Air-Filter Units
Smoke and fire dampers	UL-555, 1999	Fire Dampers
	UL-555S, 1999	Leakage Rated Dampers for Use in Smoke Control Systems
	NFPA 90A-1999	Installation of Air Conditioning and Ventilation Systems

9.5 Other Auxiliary Systems

9.5.1 Fire Protection Program

The fire protection (FP) system detects and suppresses fires and is an integral part of the AP1000 FP program. The FP review criteria for the AP1000 are specified in SECY-90-016, “Evolutionary Light Water Reactor (LWR) Certification Issues and Their Relationship to Current Regulatory Requirements,” SECY-93-087, “Policy, Technical, and Licensing Issues Pertaining to Evolutionary and Advanced Light-Water Reactor Designs,” and SECY-94-084, “Policy and Technical Issues Associated with the Regulatory Treatment of Non-Safety Systems in Passive Plant Designs.” In addition, 10 CFR 52.48 specifies that the design will comply with the requirements specified in 10 CFR 50.48, “Fire Protection,” and GDC 3, “Fire Protection.” Conformance with the SRP is addressed in 10 CFR 50.34(g), which specifies that applications include an evaluation of the facility against the SRP. BTP Chemical and Mechanical Engineering Branch (CMEB) 9.5-1, “Guidelines for Fire Protection for Nuclear Power Plants,” provides the FP guidance for nuclear power plants specified in the SRP.

In addition to the guidance detailed in the BTP, the staff specified in SECY-90-016, SECY-93-087, and Section 9.3 of NUREG-1242, “NRC Review of Electric Power Research Institute’s Advanced Light Water Reactor Utility Requirements Document,” Volume 3, that the advanced light-water reactors (ALWRs) should provide an enhanced level of FP to ensure that safe shutdown can be achieved, assuming all equipment in any one fire area is rendered inoperative as a result of fire damage and that reentry into the fire area by plant personnel for repairs or operator actions is not possible. The control room and the containment are excluded from this criterion, provided an independent alternative shutdown capability is provided for a control room fire and that FP for redundant divisions located inside containment is provided to ensure that one shutdown division will be free of fire damage following a fire inside the containment.

The design should also ensure that smoke, hot gases, and fire suppressants do not migrate into other fire areas to the extent that they could adversely affect safe-shutdown capabilities, including operator actions. In response to RAI 280.009, the applicant confirmed that when a fire was postulated in a fire area, all components in the fire area are assumed to be inoperable, whether this results from fire or smoke damage. All components in the neighboring area were also assumed to be inoperable due to fire or smoke damage.

The NRC staff interpretations and positions, discussed above, related to FP which are published in generic communications were used as applicable in the review of the AP1000. In addition, the applicant applied the latest applicable NFPA codes, standards, and recommended practices to the FP systems and features provided in the AP1000 design. To support the AP1000 design certification, the applicant submitted WCAP-15871, "AP1000 Assessment Against NFPA 804." This report compares the AP1000 design to the 2001 edition of NFPA 804, "Fire Protection for Advanced Light Water Reactor Electric Generating Plants." In response to RAI 280.003, the applicant revised the DCD and WCAP-15871 in accordance with SECY-93-087 to ensure that the AP1000 design applies the latest industry standards endorsed by the NRC in RG 1.189, "Fire Protection for Operating Nuclear Power Plants."

DCD Tier 2, Section 9.5.1, "Fire Protection System," states that the primary objectives of the AP1000 FP program are to prevent fires and to minimize the consequences should a fire occur. In DCD Tier 2, Table 9.5.1-1, the applicant provided a point-by-point comparison of the AP1000 FP program with the BTP. In addition, the FP program provides protection so that the plant can be shut down safely following a fire. The staff reviewed the AP1000 to determine its compliance with BTP CMEB 9.5-1.

The following evaluation is based on the staff's review of DCD Tier 2, Chapter 9 and Appendix 9A. All of the COL action items and deviations from BTP CMEB 9.5-1 identified and approved for the AP1000 FP program were also approved for the AP600 FP program. The staff's evaluation identified no new COL action items for the AP1000 design. Section 9.5.1.9 of this report provides a summary of all approved deviations and COL action items.

9.5.1.1 Fire Protection Program Requirements

9.5.1.1.a Fire Protection Program (Regulatory Position C.1.a of BTP CMEB 9.5-1)

The COL applicant is responsible for establishing an FP program at the facility for the protection of SSCs important to safety. The COL applicant will also establish the procedures, equipment, and personnel needed to implement the program. This is COL Action Item 9.5.1-1(a).

9.5.1.1.b Fire Hazard Analysis (Regulatory Position C.1.b of BTP CMEB 9.5-1)

The applicant has provided the fire hazard analysis for the AP1000 design in DCD Tier 2, Section 9.5.1 and Appendix 9A. This analysis demonstrates that the plant will maintain the ability to perform safe-shutdown functions, minimize radioactive releases to the environment, identify fire hazards and appropriate protection, and verify that the NRC FP guidelines (e.g., BTP CMEB 9.5-1, SRP, etc.) have been met. In RAI 280.007, the staff asked the applicant to resolve a discrepancy in Section 2.4 of WCAP-15871, which indicated that an analysis of the potential effects of a fire on the release of contamination had not been included. The applicant indicated that WCAP-15871 would be revised to reflect that the design was appropriately evaluated, as already stated in DCD Tier 2, Section 3.11, and Item 12 of DCD Tier 2, Table 9.5.1-1. The applicant issued a revision to WCAP-15871 in December 2002 which addressed the staff's concerns. The COL applicant is responsible for revising the fire hazard analysis to reflect the actual plant configuration. This is COL Action Item 9.5.1-2.

The staff has determined that the following design commitments included in the DCD Tier 2 figures identified below will require NRC review and approval prior to implementation of any design change sought by a COL applicant or licensee. The commitments identified below should be listed as Tier 2[*] information in the proposed rule certifying the AP1000 design.

AP1000 DCD	DESCRIPTION
Figure 9A-1	Nuclear Island Fire Area Plan
Figure 9A-2	Turbine Building Fire Area Plan
Figure 9A-3	Annex I & II Building Fire Area Plan
Figure 9A-4	Radwaste Building Fire Area Plan
Figure 9A-5	Diesel Generator Building Fire Area Plan

9.5.1.1.c Fire Suppression System Design Basis (Regulatory Position C.1.c of BTP CMEB 9.5-1)

The fire suppression systems located inside the containment and outlying buildings are subject to a single active failure or crack that could impair both the primary and backup fire suppression capabilities. This is not consistent with the guidance specified in BTP CMEB 9.5-1. The fire suppression systems located inside the containment are qualified to seismic Category I criteria, which reduces the potential for a failure of the system. The buildings outside containment do not contain safety-related equipment or present an exposure hazard to structures containing safety-related equipment. Manual fire suppression capability using hose lines connected to the outside hydrants of the yard main can be provided in the event of a failure of the interior fire suppression systems. On the basis of the seismic qualification of the fire suppression system located inside containment, the absence of safety-related equipment in the outlying buildings, and the manual suppression capability using the outside hydrants, the staff concludes that this alternative means of fire protection is acceptable.

The staff also concludes that the applicant identified no other exceptions to the guidance specified in BTP CMEB 9.5-1 related to the design basis for the fire suppression system. Therefore, the staff concludes that the design of the AP1000 fire suppression system is acceptable. This is Deviation 9.5.1-1.

9.5.1.1.d Alternative/Dedicated Shutdown (Regulatory Position C.1.d of BTP CMEB 9.5-1)

The staff identified in RAI 280.004 that Items 75 and 76 of DCD Tier 2, Table 9.5.1-1, stated that alternative or dedicated shutdown capability were not necessary. These statements are incorrect and inconsistent with the staff's position in BTP CMEB 9.5-1 on alternative/dedicated shutdown. Therefore, the applicant revised the information in DCD Tier 2, Table 9.5.1-1, to remain consistent with the staff's alternative/dedicated shutdown position developed for the AP1000. The staff has determined that the applicant did remain consistent with the staff's position, as identified in DCD Tier 2, Chapter 9 and Table 9.5.1-1.

9.5.1.1.e Implementation of Fire Protection Program (Regulatory Position C.1.e of BTP CMEB 9.5-1)

The COL applicant is responsible for implementing an FP program prior to receiving fuel on site for both the fuel storage areas and the entire unit prior to reactor startup. This is COL Action Item 9.5.1-1(b).

9.5.1.2 Administrative Controls (Regulatory Position C.2 of BTP CMEB 9.5-1)

The COL applicant is responsible for establishing administrative controls to maintain the performance of the FP systems and personnel. This is COL Action Item 9.5.1-1(c). In addition, based on insights from the PRA, Westinghouse included a combined license item in DCD Tier 2, Section 9.5.1.8 which states that the combined license applicant will establish procedures to address a fire watch for fire areas breached during maintenance. This is COL Action Item 9.5.1-3.

9.5.1.3 Fire Brigade (Regulatory Position C.3 of BTP CMEB 9.5-1)

The COL applicant is responsible for establishing a site fire brigade trained and equipped for firefighting to ensure adequate manual firefighting capability for all plant areas containing SSCs important to safety. This is COL Action Item 9.5.1-1(d).

9.5.1.4 Quality Assurance Program (Regulatory Position C.4 of BTP CMEB 9.5-1)

The COL applicant is responsible for establishing a quality assurance program to ensure that the guidelines for the design, procurement, installation, and testing, as well as the administrative controls for the FP systems are satisfied. This is COL Action Item 9.5.1-1(e).

9.5.1.5 General Plant Guidelines (Regulatory Position C.5 of BTP CMEB 9.5-1)

9.5.1.5.a Building Design (Regulatory Position C.5.a of BTP CMEB 9.5-1)

The safety-related structures (i.e., the containment and auxiliary building NRCAs) are separated from non-safety-related structures (i.e., the turbine building, annex building, radwaste building, DG building, and auxiliary building RCAs) by barriers having a minimum fire resistance rating of 3 hours. With the exception of the control room, the remote shutdown workstation, and the containment, fire barriers with a minimum fire resistance rating of 3 hours are provided to separate redundant divisions of the passive safety-related systems.

Openings through fire barriers for pipe conduit and cable trays are sealed with noncombustible materials to provide a fire resistance rating equal to that required by the barrier, qualified in accordance with the criteria specified in BTP CMEB 9.5-1. Penetrations for ventilation systems are protected in accordance with the criteria specified in NFPA 90A. Doors installed in fire barriers are qualified in accordance with the criteria specified in NFPA 80, “Fire Doors and Windows.” The COL applicant is responsible for inspecting and maintaining the fire doors, providing access to keys for the fire brigade, and marking exit routes. This is COL Action Item 9.5.1-1(f).

The use of gypsum wallboard, which the applicant proposed to install in lieu of concrete to enclose those personnel access and egress routes meeting the criteria of BTP CMEB 9.5-1, was unresolved and was identified as Open Item 9.5.1-1 in the DSER. In various letters and DCD revisions, the applicant proposed concrete/steel composite material to enclose all personnel access or egress routes in the AP1000 design. Section 9.5.1.9 of this report provides a more detailed discussion of the applicant's proposed concrete/steel composite material for stair towers.

The AP1000 design has no cable spreading rooms. Therefore, the guidance specified in BTP CMEB 9.5-1 addressing the separation of cable spreading rooms is not applicable. In addition, the AP1000 design does not use gaseous suppression systems. Therefore, the guidance specified in BTP CMEB 9.5-1 addressing gaseous suppression systems is not applicable.

Interior finish, wall, ceiling, structural components, thermal insulation, radiation shielding, and soundproofing materials used in the AP1000 are noncombustible. Metal deck roof construction is noncombustible and listed as Class I in the Factory Mutual Research Corporation (FMRC) Approval Guide, "Equipment, Materials, Services for Conservation of Property."

The cables used in the plant are qualified in accordance with the criteria specified in Institute for Electrical and Electronic Engineers (IEEE) Std 1202, "Standard for Flame Testing of Cables for Use in Cable Tray in Industrial and Commercial Occupancies." During its review of the AP600, the staff approved the use of the 25.4-cm (10-in.) -wide ribbon burner specified in IEEE 383, "IEEE Standard for Qualifying Class 1E Electric Cables and Field Splices for Nuclear Power Generating Stations," and IEEE Std 1202 as the only acceptable test procedure. The applicant verified in its response to RAI 280.002 that it intended to remain consistent with the AP600 design and use only the 25.4-cm (10-in.)-wide ribbon burner cable for the AP1000. The use of the 25.4-cm (10-in.)-wide ribbon burner for testing cable for the AP1000 design is acceptable because it is in accordance with IEEE Std 383.

With the exception of the combustible cable insulation installed in the underfloor and ceiling spaces in the MCR, TSC, and remote shutdown workstation, the concealed spaces are free of combustible materials. BTP CMEB 9.5-1 specifies that concealed spaces should be devoid of combustibles. Fire detection is provided in the concealed areas containing cables. This alternative protection provides an equivalent level of safety as that specified in BTP CMEB 9.5-1 and, therefore, is acceptable. This is Deviation 9.5.1-2.

Transformers installed in safety-related areas are either of the dry type or contain a noncombustible liquid. Outdoor transformers are located at least 15.2 m (50 ft) from other structures, or are separated by blank fire walls with a minimum fire resistance rating of 3 hours. Outdoor oil-filled transformers are provided with oil containment or drainage away from structures.

Floor drains of adequate capacity are provided in areas containing safety-related equipment to remove fire suppression water discharged from fixed or manual fire suppression systems. The COL applicant is responsible for collecting and sampling water drainage from areas that may contain radioactivity. This is COL Action Item 9.5.1-1(g).

Drains installed in areas containing combustible liquids are equipped with backflow prevention to preclude the flow of combustible liquids into areas containing safety-related equipment.

The applicant identified two exceptions from the guidance specified in BTP CMEB 9.5-1. The first exception relates to the cable insulation installed in the concealed spaces of the MCR, TSC, and remote shutdown workstation. This exception is acceptable because fire protection is provided in the concealed areas containing cables. The second exception relates to the use of gypsum stair towers and is identified as Open Item 9.5.1-1 in the DSER. Section 9.5.1.9 of this report provides a detailed discussion of the applicant's proposed concrete/steel composite material which it will use in lieu of gypsum wallboard to enclose stair towers.

This exception is acceptable because the applicant's proposed concrete/steel composite material, which it will use to enclosed personnel access and egress routes, meets the criteria of BTP CMEB 9.5-1.

9.5.1.5.b Safe Shutdown Capability

9.5.1.5.c Alternative or Dedicated Shutdown Capability (Regulatory Positions C.5.b and C.5.c of BTP CMEB 9.5-1)

The AP1000 criteria for the protection of safe and cold shutdown capability following a single fire in any fire area are as follows:

- Safe shutdown following a fire is defined for the AP1000 as the ability to achieve and maintain the RCS temperature below 215.6 °C (420 °F) without venting the primary coolant from the RCS. This is a departure from the BTP CMEB 9.5-1 criteria applied to the evolutionary plant designs and the existing plants, in which safe shutdown for fires applies to both hot and cold shutdown capability. This position is consistent with SECY-94-084 and, therefore, is acceptable. This is Deviation 9.5.1-3.

- Cold shutdown for the AP1000 is defined as the ability to achieve and maintain the RCS below 93.3 °C (200 °F), consistent with the criteria applicable to the evolutionary designs and existing plants and, therefore, is acceptable.

The use of the non-safety-related normal shutdown systems and/or the safety-related passive systems is acceptable to the staff to achieve and maintain safe shutdown following a fire. The safety-related passive systems are considered an alternate/dedicated shutdown method, as described in BTP CMEB 9.5-1, for fire areas where the normal shutdown systems have not been protected in accordance with the guidance prescribed in BTP CMEB 9.5-1. Consistent with the FP criteria for ALWRs specified in SECY-90-016 and SECY-93-087, redundant divisions of these systems shall be separated, such that a fire in any fire area outside of the containment or the MCR will not impair the plant's capability to achieve and maintain safe shutdown as defined above, assuming a loss of all equipment in the affected fire area.

Consistent with SECY-90-16, the safe-shutdown analysis may not consider personnel entry into the affected fire area to repair or operate equipment to achieve safe shutdown. Personnel entry into the affected fire area to repair or operate equipment necessary to achieve and maintain cold shutdown of the AP1000 is acceptable, because of the AP1000's unique capability to remain in safe shutdown for an extended period of time using only passive systems.

The criteria in BTP CMEB 9.5-1 concerning cold shutdown capability deviates from the criteria in SECY-93-087, SECY-94-084, and SECY-90-016 when applied to the evolutionary reactor designs, but is consistent with the criteria applicable to existing plants. To enhance the survivability of the normal safe shutdown and cold shutdown capability in the event of a fire, and to reduce the reliance on the infrequently utilized safety-related passive systems, automatic suppression will be provided in those fire areas outside containment where a fire could damage the normal shutdown capability or result in a spurious operation of equipment that could lead to a venting of the RCS. This criterion is unique to the AP1000 advanced reactor designs and does not ensure that the normal shutdown capability will be free of fire damage, or that the equipment necessary to achieve and maintain cold shutdown can be repaired within 72 hours. This is consistent with SECY-94-084 and is acceptable because the design utilizes passive safety-related systems as the alternative dedicated safe shutdown. This is Deviation 9.5.1-4.

As a result of the inability of the fire brigade to rapidly enter the AP1000 containment in the event of a fire, and the potential for damage to safety-related and normal shutdown equipment, in addition to potential spurious actuation(s) resulting in a venting of primary coolant from the RCS, the protection of circuits and equipment inside containment should be enhanced beyond the criteria specified in BTP CMEB 9.5.1 for existing plants, consistent with the staff's technical position stated in Section 9.3 of NUREG-1242.

The applicant provided adequate suppression and detection of the equipment and circuits located inside containment that are required for safe shutdown. This provides reasonable assurance that one division of safety-related equipment will remain free of fire damage, in accordance with the criteria specified in NUREG-1242. Complete fire barrier separation cannot be provided inside of containment due to the need to maintain the free exchange of gases for purposes such as passive containment cooling. The location of safety-related equipment and routing of Class 1E electrical cable in separate fire zones enhances the separation of redundant safe-shutdown components.

Hose stations for manual suppression are provided inside containment; however, because of the potential hazard associated with personnel entry into containment during a plant transient, the response of the plant fire brigade may be significantly delayed. Therefore, no credit for manual suppression of fires inside containment during power operations is considered acceptable by the staff.

In fire zone 1100 AF 11300B, the applicant provided a manually actuated water spray system over the non-safety-related open cable trays to limit smoke and heat generation. Both divisions of the passive residual heat removal (PRHR) control valves and PRHR flow transmitters are located in this zone in close proximity to each other. These valves are separated by a noncombustible steel or steel composite barrier. Separate fire detectors are provided near each valve. No exposed cables exist in fire zone 1100 AF 11300A, which is adjacent to fire zone 1100 AF 11300B. The applicant has provided reasonable assurance that one division of the normal or passive safe-shutdown capability located inside containment will be maintained free of fire damage; therefore, this aspect of the design is acceptable.

The applicant included the reactor head vents for consideration as a high/low-pressure interface, in accordance with the guidance provided in GL 81-12, "Fire Protection Rule." Inside containment, the cables for the control of one head vent valve in each flow path are routed in separate conduits to prevent a spurious actuation of both valves in the flow path. In areas outside containment (i.e., the MCR and the remote shutdown workstation), the power and control circuits are located in separate fire areas. The soft controls located in the MCR and remote workstations are not susceptible to fire-induced spurious actuation. The dedicated switches in the MCR are located on separate panels, such that a fire may short the switches on one panel but the unaffected panel will be deenergized before spurious actuation of two valves in the same flow path.

The applicant addressed the spurious actuation of the automatic depressurization system (ADS), resulting from hot shorts of the control circuits for motor-operated valves from a fire in the MCR, remote shutdown workstation, dc equipment rooms, and Class 1E penetration rooms. Separation and prompt operator actions are credited to minimize the potential for spurious actuation of the ADS. The spurious actuation of the ADS does not result in an unrecoverable plant configuration or prevent safe shutdown. In addition, as a result of insights from the PRA DCD Tier 2, Section 9.5.1.8 indicates that the combined license applicant will provide an analysis that demonstrates that operator manual actions which minimize the probability of the potential for spurious ADS actuation as a result of a fire can be accomplished within 30 minutes following detection of the fire and the procedure for the manual actuation of the fire water containment supply isolation valve to allow fire water to reach the automatic fire suppression system in the containment maintenance floor. This is COL Action Item 9.5.1-4.

As stated in its response to RAI 280.010, the applicant also considered in the AP1000 system spurious actuations of the passive safety systems, other than the ADS, due to fire, and potential spurious actuations of non-safety systems due to fire, as documented in DCD Tier 2, Section 9A.3.7.1.2. The AP1000 design does not allow the spurious actuation of a non-safety system to defeat the passive safety systems. The staff concludes, based on the above review, that the safe-shutdown capability and the alternative dedicated shutdown capabilities are acceptable.

9.5.1.5.d Control of Combustibles (Regulatory Position C.5.d of BTP CMEB 9.5-1)

Safety-related systems are separated from concentrations of combustible materials, where practical. Where separation is not possible, the design provides for appropriate FP based on the fire hazard analysis. BTP CMEB 9.5-1 specifies that bulk gas storage tanks should not be located inside structures containing safety-related equipment. However, breathing air storage tanks for the AP1000 design are located in the auxiliary building NRCA. These tanks are safety-related and are provided with overpressure protection and, therefore, are acceptable. This is Deviation 9.5.1-5. High-pressure gas storage containers are located in accordance with the guidance prescribed in BTP CMEB 9.5-1.

The COL applicant is responsible for the control of the use of compressed gases inside structures. This is COL Action Item 9.5.1-1(h).

The use of plastic materials in the plant is minimized through design and administrative controls. The storage of flammable liquids complies with the criteria specified in NFPA 30, “Flammable and Combustible Liquids Code,” referenced in BTP CMEB 9.5-1 and RG 1.189.

Hydrogen lines in safety-related areas are designed to seismic Category I requirements. The design of the plant’s hydrogen system complies with the criteria specified in NFPA 50A, “Standard for Gaseous Hydrogen Systems at Consumer Sites,” referenced in BTP CMEB 9.5-1 and RG 1.189.

With the exception of the breathing air storage tanks for the MCR, the applicant identified no exceptions to the guidance specified in BTP CMEB 9.5-1. The staff finds that the applicant meets BTP CMEB 9.5-1, with this one exception. Therefore, this aspect of the AP1000 design is acceptable.

9.5.1.5.e Cable Construction (Regulatory Position C.5.e of BTP CMEB 9.5-1)

Cable trays, conduit, and other electrical raceways are constructed of noncombustible and metallic materials, in accordance with the criteria specified in BTP CMEB 9.5-1. Electrical raceways are only used for cables.

Safety-related cable trays located outside of containment are separated from redundant divisions and non-safety-related areas by 3-hour, fire-rated barriers. Cable trays containing safety-related cables, located inside containment, are enclosed in noncombustible steel or steel composite materials. Safety-related cable trays are provided with line-type heat detection and are designed to allow wetting with fire suppression water without causing electrical faults. With the exception of the containment, safety-related cable trays are accessible for manual firefighting. In fire zone 1100 AF 11300B, the applicant provided a manually actuated water spray system over the non-safety-related open cable trays in this zone.

Electrical cable is qualified in accordance with the criteria specified in IEEE Std 1202. Miscellaneous storage and piping for combustible liquids or gases are located so as not to present an exposure hazard to safety-related systems. In accordance with BTP CMEB 9.5-1, the applicant provided reasonable assurance that one division of the safety-related cables will remain free of fire damage. Therefore, the staff finds this aspect of the design to be acceptable.

9.5.1.5.f Ventilation (Regulatory Position C.5.f of BTP CMEB 9.5-1)

In accordance with BTP CMEB 9.5-1, the ventilation system is designed to allow smoke and other combustion products following a fire to be discharged to an area that will not affect safety-related equipment.

DCD Tier 2, Section 9A.3.1.1, discusses ventilation for the containment/shield building. Smoke control for this area consists of VFS containment isolation valves. If open, they are closed by operator action to control the spread of fire and smoke. After the fire, smoke is removed from the fire area by portable exhaust fans and flexible ductwork.

DCD Tier 2, Section 9A.3.1.2 and Table 9A-4 discuss smoke control for the NRCA portion of the auxiliary building, including a summary of the ventilation systems serving fire areas containing Class 1E components. This section also describes the approach to smoke control for fire areas in the NRCA portion of the auxiliary building that contain the main Class 1E electrical equipment rooms served by the VBS.

DCD Tier 2, Section 9A.3.1.3, discusses smoke control for the RCA portion of the auxiliary building. The VAS serves this fire area on a once-through basis. Smoke is removed from this fire area by using portable exhaust fans and flexible ductwork.

DCD Tier 2, Section 9A.3.2, discusses the smoke control features in the turbine building. The VTS uses roof-mounted exhaust ventilators to pull air through wall louvers. The smoke and heat vents and, if available, the roof-mounted exhaust ventilators, vent smoke to outside areas to prevent smoke migration. The dedicated smoke and heat vents provide additional assurance that excessive smoke and heat cannot build up at the turbine building ceiling, and are designed to conform to NFPA 204, "Standard for Smoke and Heat Venting."

DCD Tier 2, Section 9A.3.4, discusses annex building smoke control features. For the elevator shaft and elevator, smoke is removed using the wall exhaust fan or portable exhaust fans and flexible ductwork. Other areas within the annex building are exhausted using the VXS. In the ancillary DG room of the annex building, automatic suppression is provided. After a fire, smoke is removed from this area by using portable exhaust fans and flexible ductwork.

In the DG building, discussed in DCD Tier 2, Section 9A.3.6, smoke and heat ventilation capability is provided. Smoke control features for this area include manually turning on ventilation exhaust fans mounted on the roof over the fire area, or opening the roll-up door and personnel doors and utilizing portable exhaust fans.

The release of smoke and hot gases to the environment is monitored in accordance with the guidance specified in RG 1.101, "Emergency Planning and Preparedness for Nuclear Power Plants." The applicant evaluated the ventilation systems to ensure that inadvertent operation or single failures will not violate the RCAs of the plant.

The power supply and control for the ventilation systems are routed outside of the fire area served by the system. Air intakes for ventilation systems serving areas containing safety-related equipment are remotely located away from the exhaust air outlets and smoke vents of other fire areas.

The AP1000 design includes no safety-related ventilation systems; therefore, guidance related to engineered safety feature filters and gaseous suppression systems is not applicable to the AP1000.

The applicant evaluated the smoke control capability of the normal ventilation system against the criteria specified in NFPA 92A, "Recommended Practice for Smoke-Control Systems," including stair tower pressurization in the auxiliary building. Specifically, the applicant provided dedicated fans to maintain the minimum design pressure difference across the doors in stair towers S01 and S02, in accordance with the guidance specified in NFPA 92A. The staff finds this acceptable.

The staff determined that the applicant demonstrated that the ventilation system is designed to discharge smoke and other combustion products following a fire to an area that will not affect safety-related equipment, as specified in BTP CMEB 9.5-1. Therefore, the staff finds this aspect of the AP1000 design to be acceptable.

9.5.1.5.g Lighting and Communication (Regulatory Position C.5.g of BTP CMEB 9.5-1)

BTP CMEB 9.5-1 recommends that the design should include fixed, self-contained lighting units with individual 8-hour battery supplies. However, the AP1000 design utilizes alternate emergency lighting in the MCR and remote shutdown workstation that is powered by the

Class 1E dc and uninterruptible power supply (UPS). This has an expected duration of 72 hours in the event of a loss of normal ac power. A loss of the emergency lighting in either the MCR or the remote shutdown workstation will not result in a loss of the emergency lighting in the other area. In the event of a loss of the normal lighting, the emergency lighting in other plant areas is provided by 8-hour, battery-powered, fixed, self-contained units to provide safe ingress and egress of personnel and the operation of equipment following a fire. Portable battery-powered lighting is provided for emergency use by plant personnel. The staff finds this acceptable because the AP1000 design ensures lighting to areas vital to safe shutdown in the event of a fire. This is Deviation 9.5.1-6.

Fixed emergency communications are provided at selected locations, independent of the normal plant communications system.

The COL applicant is responsible for providing portable radio communication for use by the plant fire brigade. This is COL Action Item 9.5.1-1(i).

The applicant demonstrated that the emergency lighting and communications, available in the event of a fire, will provide a level of protection equivalent to that specified in BTP CMEB 9.5-1. Therefore, this aspect of the AP1000 design is acceptable.

9.5.1.6 Fire Detection and Suppression (Regulatory Position C.6 of BTP CMEB 9.5-1)

The COL applicant is responsible for ensuring that any deviations from the applicable NFPA codes and standards, in addition to those specified in the DCD, are incorporated into the final safety analysis report (FSAR) with appropriate technical justification. This is COL Action Item 9.5.1-5.

9.5.1.6.a Fire Detection (Regulatory Position C.6.a of BTP CMEB 9.5-1)

Fire detection systems designed and installed in accordance with the criteria specified in NFPA 72, “Protective Signaling Systems,” are provided in all plant areas that contain or present a potential fire exposure to safety-related equipment. The applicant identified no exceptions to the guidance specified in BTP CMEB 9.5-1 and the staff agrees. Therefore, this aspect of the design is acceptable.

9.5.1.6.b Fire Protection Water Supply (Regulatory Position C.6.b of BTP CMEB 9.5-1)

The fire water supply system is designed in accordance with BTP CMEB 9.5-1 and the applicable NFPA standards. The AP1000 design includes an underground yard fire main loop, separate from the sanitary or SWS, designed and installed in accordance with the criteria specified in NFPA 24, “Installation of Private Fire Service Mains and Their Appurtenances.” In addition, indicating isolation valves are provided to permit maintenance or repair of the fire main and outside hydrants without interrupting the water supply to both the primary and backup fire suppression capability in areas that contain or present an exposure to safety-related equipment. The applicant states that the AP1000 design is a single-unit plant; therefore, cross-connections at multiunit sites is not part of the AP1000 design.

Two redundant 100-percent capacity fire pumps (one diesel and one electric), designed and installed in accordance with the criteria specified in NFPA 20, “Centrifugal Fire Pumps,” are provided. A motor-driven jockey pump is used to keep the fire water system full of water and pressurized, as required. Each pump and its driver and controls are separated from the remaining fire pumps by a 3-hour-rated fire wall. The fire pumps can be aligned through normally closed valves or through temporary connections to supply water for postaccident services. These include refilling of the PCS water supply tank or supplying the containment spray following a severe accident.

In addition, Section 7.2 of WCAP-15871 states that the fire water supply is based on the largest expected flow rate, but will not be less than 1135.62 kL (300,000 gallons). This flow rate is based on 1892.71 L/min (500 gpm) for manual hose streams plus the largest design demand of any sprinkler or fixed water supply, as determined by NFPA 13, “Installation of Sprinkler Systems,” or NFPA 15, “Water Spray Fixed Systems for Fire Protection.”

The outside manual hose installation is sufficient to provide an effective hose stream to any onsite location that could present a fire exposure hazard to structures containing safety-related equipment. Fire hydrants are installed approximately every 76.2 m (250 ft) on the yard main. Hose houses are provided in accordance with the criteria specified in NFPA 24. Threads compatible with the local fire department are provided on all hydrants, hose couplings, and standpipe risers.

Fire water is supplied from two separate fresh water storage tanks. The storage capacity of each tank is sufficient to maintain the design fire pump flow rate for at least 2 hours. Either tank can be automatically refilled within 8 hours. Freeze protection is provided as needed using electric immersion heaters. The primary fire water tank is dedicated to the FP system. The secondary fire water tank serves the raw water system, but contains water for use by the FP system and the containment spray system. The deviation from Regulatory Position C.6.b of BTP CMEB 9.5-1 provides adequate defense-in-depth and will not adversely affect the performance of the FP water supply. Therefore, it is acceptable. This is Deviation 9.5.1-10.

The fire water tanks are permanently connected to the suction piping of fire pumps and are arranged so that the pumps can take suction from either or both tanks. Piping between the fire water sources and the fire pumps complies with NFPA 20. A failure in one tank or its piping cannot cause both tanks to drain.

The standpipe system for areas containing equipment required for safe shutdown following an SSE is designed and supported so that it can withstand the effects of an SSE and still remain functional. The water supply for the seismic standpipe system comes from the PCS ancillary water storage tank and the safety-related PCS storage tank, as stated in DCD Tier 2, Section 9.5.1.2.1.5. These tanks are not designed in accordance with the criteria specified in NFPA 22, “Water Tanks for Private Fire Protection.” This system normally operates independently of the rest of the FP system. Its volume of water is sufficient to supply two hose streams, each with a flow of 283.9 L/min (75 gpm), for 2 hours. This is Deviation 9.5.1-7. In the event that the PCS is unavailable or additional water is needed, the seismic standpipe system can be supplied from the fire main by manually opening the normally closed cross-connect valve from the plant fire main. On this basis, the staff concludes that the safety-related storage tanks and the manual opening of the cross-connect valve are acceptable. These are Deviations 9.5.1-7 and 9.5.1-8, respectively.

The PCS water recirculation pumps are not designed and installed in accordance with the criteria specified in NFPA 20. This deviation from the NFPA standards will not adversely affect the performance of the seismically qualified portions of the FP water supply system and, therefore, is acceptable. This is Deviation 9.5.1-9.

9.5.1.6.c Sprinkler and Standpipe Systems (Regulatory Position C.6.c of BTP CMEB 9.5-1)

Automatic sprinkler systems are provided in accordance with BTP CMEB 9.5-1 and are designed and installed in accordance with the criteria specified in NFPA 13, with an exception concerning individual fire department connections to each sprinkler system. Because the sprinkler systems are supplied by the plant's FP water supply, individual connections are not necessary. This is Deviation 9.5.1-11. The selection of automatic suppression systems for each plant area is based on the guidance of NFPA 804. Fixed automatic fire suppression is based on the results of the FP analysis. The staff concludes that the automatic sprinkler system design meets the guidance of BTP CMEB 9.5-1 and, with the exception of this deviation, is acceptable.

Standpipes for each building are designed and installed in accordance with the criteria specified in NFPA 14, "Installation of Standpipe and Hose Systems," for Class III service except for (1) the water supply to the standpipe inside containment is manually operated, and (2) the containment isolation valves controlling the water supply to the standpipes inside containment are not listed by an independent testing laboratory for FP service. The staff concludes that these deviations from the code will not adversely affect the performance of the hose station and standpipe system because these deviations will not prevent manual fire suppression activities inside containment. Therefore, these deviations are acceptable. These are Deviations 9.5.1-12 and 9.5.1-13.

9.5.1.6.d Halon Systems (Regulatory Position C.6.d of BTP CMEB 9.5-1)

Halon fire suppression systems are not used in the design of the AP1000; therefore, the guidance specified in BTP CMEB 9.5-1 is not applicable.

9.5.1.6.e Carbon Dioxide Systems (Regulatory Position C.6.e of BTP CMEB 9.5-1)

Carbon dioxide fire suppression systems are not used in the design of the AP1000. Therefore, the guidance specified in BTP CMEB 9.5-1 is not applicable.

9.5.1.6.f Portable Fire Extinguishers (Regulatory Position C.6.f of BTP CMEB 9.5-1)

Portable fire extinguishers are provided in accordance with the criteria specified in NFPA 10, "Portable Fire Extinguishers." They are provided throughout the plant and are readily accessible for use in high radiation areas. However, they are not located within those areas unless the FP analysis indicates that a specific requirement exists. The applicant identified no exceptions to the guidance specified in BTP CMEB 9.5-1. The staff agrees that the portable fire extinguishers meet BTP CMEB 9.5-1 and, therefore, are acceptable.

9.5.1.7 Specific Plant Areas (Regulatory Position C.7 of BTP CMEB 9.5-1)

9.5.1.7.a Primary and Secondary Containment (Regulatory Position C.7.a of BTP CMEB 9.5-1)

Fire protection for the containment is provided as specified in the applicant's fire hazard analysis. A lube oil collection system for the RCPs is not required because the four canned RCPs use water for lubrication and do not contain oil. Operation of the FP suppression systems located inside containment will not compromise the integrity of the containment or other safety-related systems. Fire detection is provided in the primary containment and annulus for each fire hazard. DCD Tier 2, Appendix 9A, identifies the type of detection used and the location of the detectors most suitable for the specific fire hazards. Manual hose stations are provided in the primary containment, as identified in Appendix 9A. Redundant divisions of safety-related cables located in the middle annulus are separated by 3-hour fire barriers. Division B and D cables are located in the upper annulus, and Division A and C cables are located in the lower annulus.

The staff concludes that the applicant provided adequate FP inside primary containment to provide reasonable assurance that one division of safe-shutdown equipment and cables will remain free of fire damage, in accordance with NUREG-1242. As stated in Appendix 9A to DCD Tier 2, Section 9A.3.1.1, the safe-shutdown components located inside the containment are primarily components of the PXS, the RCS, the steam generator system (SGS), and containment isolation. Hose stations for manual suppression are provided inside containment, however, because of the potential hazard associated with personnel entry into containment during a plant transient, the response of the plant fire brigade may be significantly delayed. Therefore, the staff does not consider any credit for manual suppression of fires inside containment during power operations to be acceptable. The applicant located a manual (operated from the MCR) water spray system in fire zone 1100 AF 11300B over the exposed cable trays. The applicant identified no exceptions to the guidance specified in BTP CMEB 9.5-1, and the staff agrees that fire protection for the containment meets BTP CMEB 9.5-1. The staff finds this acceptable.

The COL applicant is responsible for fire protection inside containment during refueling and maintenance. This is COL Action Item 9.5.1-1(j).

9.5.1.7.b Control Room Complex (Regulatory Position C.7.b of BTP CMEB 9.5-1)

The MCR complex is noted in Appendix 9A to DCD Tier 2 as fire zone 1242 AF 12401A. This zone is separated from the other plant areas by 3-hour-rated fire barriers. The ceiling acts as a barrier to fires in the room above the MCR. Fire detection is provided in the general area and subfloor areas. Manual hose stations and portable fire extinguishers are provided for fire suppression. Smoke removal is provided by the nonradioactive ventilation system. Breathing apparatus is provided for control room personnel. The above provisions are in accordance with BTP CMEB 9.5-1.

Automatic suppression is not provided in the control room or peripheral rooms in this fire area. Fire detection is not provided in the cabinets or consoles. These omissions are not consistent with BTP CMEB 9.5-1. However, these deviations are acceptable because the control room is continuously occupied, the area fire hazard is low, manual suppression capability is available, and the remote shutdown workstation is located in a separate fire area. These are Deviations 9.5.1-14 and 9.4.1-15.

The staff concludes that the deviations from the guidance specified in BTP CMEB 9.5-1 do not adversely affect safety and, therefore, are acceptable. With the exception of these deviations, the MCR FP meets BTP CMEB 9.5-1 and, therefore, is acceptable.

9.5.1.7.c Cable Spreading Room (Regulatory Position C.7.c of BTP CMEB 9.5-1)

There are no cable spreading rooms in the AP1000. Therefore, the guidance specified in BTP CMEB 9.5-1 is not applicable.

9.5.1.7.d Plant Computer Rooms (Regulatory Position C.7.d of BTP CMEB 9.5-1)

There are no computers performing safety-related functions in the MCR complex. Non-safety-related computers outside the MCR are separated from safety-related areas by 3-hour fire barriers. The applicant identified no exceptions to the guidance specified in BTP CMEB 9.5-1. The staff agrees that the FP design in the plant computer rooms meets BTP CMEB 9.5-1, and finds this acceptable.

9.5.1.7.e Switchgear Rooms (Regulatory Position C.7.e of BTP CMEB 9.5-1)

The electrical equipment and penetration rooms associated with each safety-related division are separated from other plant areas and from redundant divisions by 3-hour, fire-rated barriers. Automatic fire detection, portable fire extinguishers, and manual hose stations are provided. Floor drains are provided for the removal of firefighting water. Smoke removal using the nuclear island nonradioactive ventilation system or portable fans and ductwork is provided for these areas. The applicant identified no exceptions to the guidance specified in BTP CMEB 9.5-1. The staff agrees that the FP design of the switchgear rooms meets BTP CMEB 9.5-1 and finds this acceptable.

9.5.1.7.f Remote Safety-Related Panels (Regulatory Position C.7.f of BTP CMEB 9.5-1)

Safety-related panels outside of the control room are separated from other plant areas by 3-hour fire barriers. Automatic fire detection, portable fire extinguishers, and manual hose stations are provided. Remote shutdown panels located in the remote shutdown workstation can be electrically isolated from the MCR by a transfer switch. Combustible materials in these areas will be controlled and limited to those required for operation. The COL applicant is responsible for controlling combustible materials. This is COL Action Item 9.5.1-1(k).

The applicant identified no deviations from the guidance specified in BTP CMEB 9.5-1. The staff agrees that the FP design of the safety-related panels outside of the control room meets BTP CMEB 9.5-1 and finds this acceptable.

9.5.1.7.g Safety-Related Battery Rooms (Regulatory Position C.7.g of BTP CMEB 9.5-1)

Safety-related battery rooms are separated from each other and from other plant areas by 3-hour fire-rated barriers. Automatic fire detection is provided in the battery rooms. Portable extinguishers and hose stations are readily available outside the battery rooms. Ventilation systems are capable of maintaining the hydrogen concentration in the battery rooms below 2 percent. A loss of the battery room ventilation system alarms in the MCR. The applicant identified no exceptions to the guidance specified in BTP CMEB 9.5-1. The staff agrees that the FP design of the safety-related battery rooms meets BTP CMEB 9.5-1 and finds it acceptable.

9.5.1.7.h Turbine Building (Regulatory Position C.7.h of BTP CMEB 9.5-1)

DCD Tier 2, Section 9A.3.2, states that a fire in the turbine building areas does not affect the plant's safe-shutdown capability. Fire areas located in the turbine building are separated from adjacent structures containing safety-related equipment by 3-hour-rated fire barriers. The fire barriers are designed to maintain structural integrity in the event of a collapse of the turbine building. Openings and penetrations are minimized and are not located in proximity to the turbine lube oil system or generator hydrogen cooling system. The applicant identified no exceptions to the guidance specified in BTP CMEB 9.5-1. The staff agrees that the FP design of the turbine building areas meets BTP CMEB 9.5-1 and finds it acceptable.

9.5.1.7.i Diesel Generators

9.5.1.7.j Diesel Fuel Storage (Regulatory Positions C.7.i and C.7.j of BTP CMEB 9.5-1)

Portable extinguishers and manual hose stations are readily available outside the fuel storage area. Drainage for firefighting water and a means for manual venting of smoke is provided.

Each DG day tank has a total capacity of 5678 L (1500 gallons). Separate 3-hour enclosures and automatic suppression are provided. The tanks are located more then 15 m (50 ft) from buildings containing safety-related equipment. The fuel supply for the ancillary DGs is not separated from the diesels by a barrier. The ancillary diesels and the tank are separated from the rest of the plant by an enclosure with a 3-hour fire rating.

On the basis of the above information, the staff concludes that the deviations identified by the applicant do not adversely affect safety and, therefore, are acceptable.

The standby DGs are located in a separate structure, remote from safety-related areas. The standby DGs are separated from each other by 3-hour fire barriers. The ancillary DGs are located in the same fire area, but are separated from the other plant areas containing safety-related equipment by 3-hour fire barriers. However, they are not separated from one another by 3-hour fire barriers. This lack of 3-hour fire barrier separation between the ancillary DGs does not adversely affect safety because the ancillary DGs are not safety-related and their failure will not adversely affect safe shutdown. Therefore, the staff finds this deviation from Regulatory Positions C.7.i and C.7.j of BTP CMEB 9.5-1 to be acceptable. This is Deviation 9.5.1-16.

Automatic fire suppression is provided in the DG and fuel storage rooms and is designed to actuate during diesel operation without affecting the diesel. Automatic detection is provided in the DG service modules only. The dry pipe sprinklers provide detection in the DG and fuel storage rooms. This deviation from Regulatory Positions C.7.i and C.7.j of BTP CMEB 9.5-1 does not adversely affect safety because the standby DGs are not safety-related and their failure does not adversely affect safe shutdown. Therefore, this deviation is acceptable. This is Deviation 9.5.1-17.

9.5.1.7.k Safety-Related Pumps (Regulatory Position C.7.k of BTP CMEB 9.5-1)

The design of the AP1000 does not require safety-related pumps for safe shutdown following a fire. Therefore, the guidance specified in BTP CMEB 9.5-1 is not applicable.

9.5.1.7.l New Fuel Storage Area (Regulatory Position C.7.l of BTP CMEB 9.5-1)

The new fuel storage pit includes automatic fire detection, hose stations, and portable extinguishers. Automatic suppression is not provided in the new fuel storage pit. Floor drains are provided to prevent the accumulation of water that could result in an inadvertent criticality. The new fuel storage pit is located in the same fire area (1200 AF 02) as the rail car bay/filter storage area. The rail car bay/filter storage area is provided with automatic suppression. The applicant identified no exceptions to the guidance specified in BTP CMEB 9.5-1. The staff agrees that the FP design for the new fuel storage area meets BTP CMEB 9.5-1 and, therefore, is acceptable.

9.5.1.7.m Spent Fuel Pool Area (Regulatory Position C.7.m of BTP CMEB 9.5-1)

The fuel-handling area includes automatic fire detection, hose stations, and portable extinguishers. Automatic suppression is not provided in the new fuel storage pit. The fuel-handling area is located in the same fire area (1200 AF 02) as the rail car bay/filter storage area. The rail car bay/filter storage area has automatic suppression. The applicant identified no exceptions to the guidance specified in BTP CMEB 9.5-1. The staff agrees that the FP design for the SFP area meets BTP CMEB 9.5-1 and, therefore, is acceptable.

9.5.1.7.n Radwaste and Decontamination (Regulatory Position C.7.n of BTP CMEB 9.5-1)

The radwaste building is separated from the other plant areas containing safety-related equipment by 3-hour, fire-rated barriers. A dedicated ventilation system is provided for the radwaste building. Floor drains are sized to handle water flow from the fixed automatic FP systems without a significant accumulation of water in the fire area. Curbed areas within the radwaste building have sufficient capacity to retain FP water, thus preventing an unmonitored release to the environment.

Automatic fire suppression is provided in the mobile systems facility, waste accumulation room, and packaged waste storage room. Fire detection and hose stations are located throughout the radwaste building.

The cask washdown pit and the waste disposal container area are located in the same fire area (1200 AF 02) as the rail car bay/filter storage area. The rail car bay/filter storage area is provided with automatic suppression. As described above, the applicant identified no exceptions to the guidance specified in BTP CMEB 9.5-1. The staff agrees that the FP design for the radwaste and decontamination areas meets BTP CMEB 9.5-1 and, therefore, is acceptable.

9.5.1.7.o Safety-Related Water Tanks (Regulatory Position C.7.o of BTP CMEB 9.5-1)

The CMTs, IRWST, and PCS tanks are not susceptible to damage from an exposure fire. The applicant identified no exceptions to the guidance specified in BTP CMEB 9.5-1. The staff agrees that the FP design for the safety-related water tanks meets BTP CMEB 9.5-1 and, therefore, is acceptable.

9.5.1.7.p Records Storage Area (Regulatory Position C.7.p of BTP CMEB 9.5-1)

Records storage areas are located and protected so that a fire in these areas will not affect safety-related systems or equipment. The applicant identified no exceptions to the guidance specified in BTP CMEB 9.5-1. The staff agrees that the FP design for the records storage area meets BTP CMEB 9.5-1 and, therefore, is acceptable.

9.5.1.7.q Cooling Towers (Regulatory Position C.7.q of BTP CMEB 9.5-1)

The cooling towers are not used as the ultimate heat sink or for FP purposes; therefore, the guidance specified in BTP CMEB 9.5-1 is not applicable. The COL applicant is responsible for fire protection for the cooling towers. This is COL Action Item 9.5.1-1(l).

9.5.1.7.r Miscellaneous Areas (Regulatory Position C.7.r of BTP CMEB 9.5-1)

Miscellaneous areas, such as shops, warehouses, auxiliary boiler rooms, fuel oil tanks, and flammable and combustible liquid storage tanks, are located and protected so that a fire, or the effects of a fire, will not affect any safety-related equipment. These areas are outside of the containment, which is separated from the other plant areas by a 3-hour fire barrier. The applicant identified no deviations from the guidance specified in BTP CMEB 9.5-1. The staff agrees that the FP design for these areas meets BTP CMEB 9.5-1 and, therefore, is acceptable.

9.5.1.8 Special Protection Guidelines (Regulatory Position C.8 of BTP CMEB 9.5-1)

9.5.1.8.a Storage of Oxygen-Acetylene Fuel Gases (Regulatory Position C.8.a of BTP CMEB 9.5-1)

The COL applicant is responsible for the proper storage of welding gas cylinders. This is COL Action Item 9.5.1-1(m).

9.5.1.8.b Storage Areas for Ion Exchange Resins (Regulatory Position C.8.b of BTP CMEB 9.5-1)

The COL applicant is responsible for the proper storage of ion exchange resins. This is COL Action Item 9.5.1-1(n).

9.5.1.8.c Hazardous Chemicals (Regulatory Position C.8.c of BTP CMEB 9.5-1)

The COL applicant is responsible for the proper storage of hazardous chemicals. This is COL Action Item 9.5.1-1(o).

9.5.1.8.d Materials Containing Radioactivity (Regulatory Position C.8.d of BTP CMEB 9.5-1)

Materials that collect and contain radioactivity, such as spent resins, charcoal filters, and HEPA filters, are stored in closed metal containers that are located in areas free from ignition sources or combustibles. The applicant identified no deviations from the guidance specified in BTP CMEB 9.5-1. The staff agrees that the FP design associated with the storage of these materials meets BTP CMEB 9.5-1 and, therefore, is acceptable.

9.5.1.9 Evaluation of Fire Protection Open Items and COL Action Items

DSER Open Item 9.5.1-1

Personnel access and egress routes are provided for each fire area. Stairwells outside containment, serving as access or egress routes, are enclosed in gypsum towers, with a minimum fire resistance rating of 2 hours. The stairwells are equipped with self-closing doors, with a fire resistance rating of 1.5 hours. In NUREG-1512, the NRC staff had previously granted Deviation 9.5.1-2 allowing the use of gypsum stair towers in lieu of concrete or masonry in the AP600 design on the basis that there were no missile hazards in the vicinity of the subject stairwells.

Following the events of September 11, 2001, the Federal Emergency Management Agency (FEMA) issued FEMA 403, “World Trade Center Building Performance Study: Data Collection, Preliminary Observations and Recommendations,” dated May 2002. Based on the performance of the gypsum stairwell enclosures in the World Trade Center following the aircraft impacts, Section 8.2.2.1 of this FEMA report recommends the use of impact-resistant enclosures around egress paths, such as stairwells.

In light of this information, the staff has reconsidered its previous acceptance of gypsum stairwell enclosures in lieu of the concrete or masonry enclosure specified by BTP CMEB 9.5-1. In RAI 280.001, the staff requested an evaluation of the stairwells that have not been enclosed in masonry or concrete towers with a minimum fire rating of 2 hours, as specified in Regulatory Position C.5.a.6. of CMEB 9.5.1. In addition, the staff requested that the applicant provide a revision to the DCD to incorporate the original BTP guidance for the use of concrete or masonry enclosures. The staff reviewed the applicant’s revised response and determined that the resolution of this issue is inadequate for the following three reasons:

(1) In place of the gypsum, the applicant proposed installation of a fire barrier material noted as a “concrete/steel composite material.” This material would be installed throughout the auxiliary, turbine, and annex buildings to enclose stairwells, as shown in the revision to Item 55 in DCD Tier 2, Table 9.5.1-1. The applicant did not demonstrate that the as-built configuration would meet the applicable regulation (GDC 3, “Fire Protection”) and the applicable guidance (BTP CMBE 9.5-1). The use of the concrete/steel composite material is inadequate for the following reasons:

    – The applicant did not submit documentation or test reports to verify the rating of the fire barrier. The documentation should demonstrate that this composite material withstood a standard fire exposure as specified in NFPA 251, “Tests of Fire Endurance of Building Construction and Materials,” also known as ASTM E119, “Standard Test Method of Fire Tests of Building Construction and

Materials." For additional guidance, see Section 3.1.6 of GL 86-10, "Implementation of Fire Protection Requirements."

– Section 3.2 of GL 86-10 provides additional guidance on fire barrier qualification. It does not appear from the information submitted that the applicant demonstrated that the composite barrier material provided an equivalent level of safety to concrete or masonry, as discussed in GL 86-10. For example, the applicant's RAI response did not discuss the following information pertaining to the fire barrier material:

  - deviations between the field installation and the tested configuration
  - ASTM E-119 acceptance criteria (hose stream tests results, temperatures on the unexposed side of the barrier, no passage of flames or ignition to unexposed side, etc.)

On this basis, the staff did not agree that the applicant demonstrated that the performance of the composite steel/concrete barrier provides a level of safety equivalent to that provided by the guidelines in BTP CMEB 9.5-1.

(2) The applicant failed to provide adequate protection for stairwells S03 and S06 in accordance with BTP CMEB 9.5-1.

BTP CMEB 9.5-1 recommends that stairwells outside of the primary containment, which serve as escape routes, access for firefighting, or access routes to areas containing equipment necessary for safe shutdown, be enclosed in concrete or masonry. In the auxiliary building, stairwell S03 provides an entry point to stairwell S06 (PCS valve room). DCD Tier 2, Section 6.2.2.2.2, identifies the PCS as a safety-related system. Stairwells S03 and S06 are located aboveground, have no adjacent structures to provide a shield or additional protection for either stair tower, and have no alternate stairwells for personnel to travel in the event that either stairwell S03 or stairwell S06 is impacted by an external missile. The applicant revised Item 55 in DCD Tier 2, Table 9.5.1-1, to state that, "There is little need for access to this room (PCS Valve Room). Protection of these stairwells by concrete or masonry walls is not required." The staff disagrees with this statement.

In the event an external missile impacts either stairwell, plant personnel located in the plant areas served by these stairwells would not have an alternate escape route to compensate for the lack of structural protection in stairwells S03 and S06. These stairwells are the primary escape routes and have not been protected in accordance with BTP CMEB 9.5-1.

(3) For those stairwells where concrete is partially installed on the exterior walls, the applicant stated that the thickness of the concrete varies from between 0.61 to 0.91 m (2 to 3 ft). For installation of the composite steel/concrete barrier on the interior walls of these stairwells, the thickness was noted as 20.3 cm (8 in.). The applicant did not present an analysis to demonstrate, from a structural design, that 20.3 cm (8 in.) of the composite material would provide a level of structural integrity equivalent to a 0.61 to 0.91 m (2 to 3 ft) thickness of concrete. On this basis, the staff does not agree that the

applicant has demonstrated that the performance of the composite steel/concrete barrier will provide a level of safety equivalent to that provided by the guidelines of BTP CMEB 9.5-1.

This was identified as Open item 9.5.1-1 in the DSER.

By letter dated July 3, 2003, the applicant provided a response to Open Item 9.5.1-1, concerning its proposed fire barrier material, which is a concrete/steel composite material manufactured by DuraSystem Barriers, Inc., for the stairwells of the auxiliary, turbine, and annex buildings. The applicant proposed to use this material in lieu of concrete or masonry towers having a minimum fire rating of 2 hours, as specified in Regulatory Position C.5.a.6 of BTP CMEB 9.5.1. The applicant stated in its response that, "the fire resistance test of the base design concrete/steel composite material is documented in Underwriters Laboratories, Inc., File R11164-1, Project 84NK1877 of October 26, 1984. The report states that the test was conducted in accordance with Standard UL 263 (ASTM E119, NFPA No. 251 and ANSI A2.1). This UL listing responds to Section 3.1.6 of GL 86-10 and a copy of the test report is available for NRC audit at Westinghouse and DuraSystem offices…."

On August 22, 2003, the staff visited the Westinghouse office in Rockville, Maryland, to audit the fire resistance test, File R11164-1, Project 84NK1877, of October 26, 1984. The staff noted that the fire test was performed according to the UL Test Assembly Design No. U031, Assembly Rating for 3 hours for Nonbearing Wall, with a panel thickness of 9.5 mm (3/8 in.). The test was conducted in accordance with ASTM E119 requirements and included hose stream tests, temperature measurements on the unexposed side, and inspection for passage of flame or ignition to the unexposed side. The test was rated for UL Test Assembly Design No. U031 for 3 hours. The staff agrees with the test results and the details of the documentation. The staff also believes that this rating is adequate and acceptable. The Regulatory Position C.5.a.6 of BTP CMEB 9.5.1 requires a minimum fire rating of 2 hours for concrete or masonry construction.

The staff reviewed the applicant's response to Open Item 9.5.1-1 and required responses to the following issues to complete its review:

(a) Provide the fire resistance rating of stairwell doors installed throughout the auxiliary, turbine, and annex buildings.

(b) Specify what UL design is used in stairwells throughout the auxiliary, turbine, and annex buildings in all drawings. The fire resistance test File R11164-1, Project 84NK1877 of October 26, 1984, refers to UL Test Assembly Design No. U031 for 3 hours.

(c) On DSER OI 9.5.1-1, page 3, the applicant stated that, "Stairwells S03 and S06 provide access to the PCS valve room. As noted in the Open Item, the PCS valve room does contain safety-related equipment. Access is not required to any of this equipment to respond to an accident…."

Clarify why access is not required to the PCS valve room, although this room contains safety-related equipment, and how the fire brigade will approach the PCS valve room for manual firefighting; safe personnel access routes and escape routes should be provided for each fire area. Stairwells outside the primary containment which serve as escape

> routes, access routes for firefighting, or access routes to areas containing equipment necessary for safe shutdown should be enclosed in masonry or concrete towers with a minimum fire rating of 2 hours and include self-closing Class B fire doors.

In response to the staff's request for clarifying information, by letter dated October 21, 2003, the applicant provided Revision 1 to Open Item 9.5.1-1. In its response to Item a above, the applicant stated that Section 9.5.1.2.1.1, "Plant Fire Prevention and Control Features, Architectural and Structural Features," of the AP1000 DCD states that the stairwell openings are protected by approved automatic or self-closing doors having a fire rating of 1.5 hours. The staff verified that in accordance with NFPA 80, "Fire Doors and Windows," 1999 Edition, and NFPA 252, "Standard Methods of Fire Tests of Door Assemblies," 2003 Edition, the fire barriers having a required fire resistance rating of 2 hours shall include only fire door assemblies having a minimum fire resistance rating of 1.5 hours. The staff finds this acceptable; the applicant meets the guidelines of BTP CMEB 9.5-1. Therefore, DSER Open Item 9.5.1-1, Item a, is resolved.

In its October 21, 2003, letter, the applicant did not provide the type of 2-hour wall design assembly, and associated fire resistance test results, to be installed using concrete/steel composite material. Rather, in response to Item b, above, the applicant provided a fire resistance test File R11164-1, Project 84NK1877 of October 26, 1984, that refers to UL Test Assembly Design No. U031 for 3 hours. The applicant did not address if it intends to utilize the 3-hour fire resistance test. In DCD Tier 2, Section 9.5.1.8 Westinghouse states that the COL applicant will address the process for identifying deviations between the as-built installation of fire barriers and their tested configurations. This is COL Action Item 9.5.1-6. Westinghouse revised DCD Tier 2, Section 9.5.1.8 to include a combined license item that states "[t]he Combined License applicant will provide 2-hour fire resistance test data in accordance with ASTM E-119 and NFPA 251 for the composite material selected for stairwell fire barriers." This is COL Action Item 9.5.1-7.

The staff will review the COL applicant's stairwell fire barriers fire resistance performance test results to determine that they perform in an equivalent manner to maintain the integrity of the enclosed stairwell in accordance Regulatory Position C.5.a.6 of BTP CMEB 9.5.1.

Therefore, DSER Open Item 9.5.1-1, Item b, is resolved.

In its October 21, 2003, letter, the applicant stated that:

> AP1000 Design Control Document, Appendix 9A, Table 9A-2 (Sheet 7 of 14) identifies the safe-shutdown components in the PCS valve room (Room 12701, Fire Area 1000 AF 01, Fire Zone 1270 AF 12701). The components in this room consist of six (2 air-operated and 4 motor-operated valves) Passive Containment Cooling Water Storage Tank (PCCWST) isolation valves and five PCCWST flow/level instruments. In the unlikely event that a fire occurred in Room 12701 to the extent that these components were rendered inoperable, the ability to achieve safe shutdown would not be compromised.
>
> Normal shutdown operations may be required in the event that a fire were to significantly damage the safe-shutdown components located in Room 12701.

> Normal shutdown operations do not require the actuation of the PCS valves located in this room.
>
> In the event of a design-basis accident the three, normally closed, PCCWST isolation valves (two air operated valves and one motor operated valve) located in Room 12701 could receive an automatic signal to open. Access to the PCS valve room is not required for their operation.
>
> There is very little combustible material in the PCS valve room fire area. In the unlikely event of a fire, the fire brigade would approach the PCS valve room (Room 12701, Fire Zone 1270 AF, Fire Area 1000 AF 01) by using the Stairwell S03 of the adjacent elevator that is attached to the outside wall on the shield building. The fire bridge would egress from Stairwell S03 (Fire Area 120A AF 02) at the El. 264’-6" platform (Fire Area 1270 AF, Fire Area 1000 AF 01). They would proceed up the included stair S06 to the PCS valve room (Room 12701) located on El. 286’-6". From this position they could utilize fire extinguishers for manual fire fighting.

The staff reviewed the applicant’s response to Item c and found it unacceptable. The staff believes that access is required to the PCS valve room (Room 12701) because it contains safety-related equipment for safe shutdown. BTP CMEB 9.5.1, Regulatory Position C.6.c.4, requires that an, “interior manual hose should be able to reach any location that contains, or could present a fire exposure hazard to, safety-related equipment with at least one hose stream….” The staff believes that for manual firefighting, fire extinguishers are not always effective, and often water hose streams are required for effective firefighting.

To resolve DSER Open Item 9.5.1-1, Item c, the staff issued RAIs to evaluate the effectiveness of fire extinguishers for suppression cable and oil fire in the PCS valve room. The RAIs requested information concerning the quantities of in situ combustibles, the type of transient combustible materials planned to be introduced during the maintenance work, and the type of portable fire extinguishers that would be provided in the PCS valve room.

In a letter dated December 22, 2003, the applicant provided the following response:

> The type of portable fire extinguishers that would be provided in the PCS valve room would be Type ABC (dry chemical) with a capacity of 20 pounds. A total of four fire extinguishers will be provided in the PCS valve room with two fire extinguishers located at El. 264'-6" lower level and two fire extinguishers located at the EL. 286'-6" upper level.
>
> In the unlikely event of a fire, the fire brigade would approach the PCS valve room (Room 12701, Fire Zone 1270 AF, Fire Area 1000 AF 01) by using the Stairwell S03 or the adjacent elevator that is attached to the outside wall on the shield building. The fire brigade would egress from Stairwell S03 (Fire Area 1204 AF 02) into the lower level of the PCS valve room (Room 12701) at the El. 264'-6" platform (Fire Zone 1270 AF, Fire Area 1000 AF 01). Portable fire extinguishers are provided at this lower level for manual fire fighting. The fire brigade would proceed up the inclined stairs S06 to upper level of the PCS valve

> room (Room 12701) located on El. 286’-6". Additional portable fire extinguishers are provided at this upper level for manual fire fighting.

The staff reviewed the applicant’s response to Item c and expressed a concern that the dry chemical portable fire extinguishers may not be adequate to completely extinguish deep-seated electrical cable fires. The staff referred to NRC Information Notice 2002-27, which addresses the extinguishment practice and discusses the need for special consideration to be given to the means of fire extinguishment and the associated effects.

During a conference call on January 23, 2004, the applicant agreed to issue a revision to Open Item 9.5.1-1, Item c, which included the following:

> In the unlikely event of a fire, the fire brigade would approach the PCS valve room (Room 12701, Fire Zone 1270 AF, Fire Area 1000 AF 01) by using the Stairwell S03 or the adjacent elevator that is attached to the outside wall on the shield building. The fire brigade would egress from Stairwell S03 (Fire Area 1204 AF 02) into the lower level of the PCS valve room (Room 12701) at the El. 264'-6" platform (Fire Zone 1270 AF, Fire Area 1000 AF 01). Two types of portable fire extinguishers (a dry chemical and water fire extinguisher) are provided at this lower level for manual fire fighting. The fire brigade would proceed up the inclined stairs S06 to upper level of the PCS valve room (Room 12701) located on El. 286'-6". Two types of portable fire extinguishers (a dry chemical and a water fire extinguisher) are also provided at this upper level for manual fire fighting.

The staff reviewed the applicant’s commitment to provide water fire extinguishers along with dry chemical extinguishers. The staff found it acceptable. Operating experience with major electrical cable fires shows that water will promptly extinguish such fires. Therefore, Open Item 9.5.1-1 is resolved.

DSER Open Item 9.5.1-2

In RAI 280.011, the NRC staff raised a concern that 41percent of the total fire-induced core damage frequency (CDF) is assigned to containment. The containment fire is a large contributor to CDF, and areas in containment exist where redundant safe-shutdown components required following a fire have not been separated by complete fire barriers. Therefore, the NRC staff requested that the applicant perform a mathematical fire model in accordance with NFPA 805, “Performance-Based Standard for Fire Protection for Light-Water Reactor Electric Generating Plants.” The fire model should demonstrate that a fire would be confined to the zone of origin so that redundant components remain free of fire damage. The applicant selected the fire-induced vulnerability evaluation (FIVE) methodology found in EPRI TR-100370, “Fire-Induced Vulnerability Evaluation (FIVE) Methodology,” issued April 1992. This is not a mathematical fire model. FIVE was approved by the NRC in the early 1990s primarily as a tool to provide a qualitative assessment of fire risk for the individual plant examination of external events (IPEEE) to perform fire probabilistic risk assessments (PRAs). The FIVE methodology is limited in that large open areas, such as those in containment, are not capable of being realistically modeled. Therefore, the NRC staff expressed concern about the appropriateness of FIVE methodology for modeling fires within containment.

The applicant responded to the RAI by stating that NFPA 805 permits the use of the FIVE methodology. The staff responded that Appendix C, Section C.2.2., "Fire Model Features and Limitations" of NFPA 805 specifically states that the limitations of each fire model should be taken into consideration, so as to produce reliable results that will be useful in decisionmaking. This section specifically states that, "Some models may not be appropriate for certain conditions and can produce erroneous results if applied incorrectly." Appendix C, Table C.2.2.(b), of NFPA 805 enables the user to select the appropriate model for a particular fire area, so as to obtain useful estimates to best approximate the conditions within an enclosure as a result of an internal fire. In addition, NFPA 805 states that the fire model shall be acceptable by the authority having jurisdiction (AHJ). In this case, the AHJ is the NRC. The NRC has not accepted the use of the FIVE methodology outside of the IPEEEs. The staff does not agree that the use of FIVE is an appropriate choice to model a fire within containment. This was identified as Open Item 9.5.1-2 in the DSER.

By letter dated August 13, 2003, the applicant provided the following response to Open Item 9.5.1-2, Revision 1, concerning the use of the FIVE methodology for fire hazard analysis:

> Westinghouse believes that our licensing submittals related to fire protection have satisfied the written regulatory requirements and guidance for Design Certification. Westinghouse has provided a fire hazards analysis in DCD Appendix 9A that demonstrates that the AP1000 complies with or requests exemptions from the requirements of BTP CMEB 9.5-1. AP1000 has used a deterministic-based approach for the fire evaluation described in Chapter 9 and Appendix 9A of the AP1000 Design Control Document (DCD). Consistent with Chapter 2 and Figure 2.2 (Methodology) of NFPA 805, AP1000 has chosen this deterministic approach to justify its compliance with the fire protection requirements of 10 CFR Part 50 and 10 CFR Part 52. NFPA 805 clearly indicates that the designer may use either the deterministic or the probabilistic method for fire evaluation. Since this hazards evaluation was deterministic, it "involves implied, but unquantified, elements of probability in the selection of specific accidents to be analyzed as design-basis event" (see NFPA 805, Section 1.6.11). The FIVE methodology was not used in the fire hazards analysis documented in AP1000 Appendix 9A to justify compliance with regulatory fire protection requirements.
>
> In addition, to comply with an NRC request to have an AP1000-specific PRA, Westinghouse has performed a fire PRA as part of the overall AP1000 PRA. 10 CFR Part 52 requires an applicant to submit a plant-specific PRA, although it does not specifically require a fire PRA. The results of the fire PRA have shown that AP1000 plant risk due to fire is extremely low. The AP1000 PRA methodology included using the FIVE methodology inside containment at NRC's request. The FIVE methodology is an acceptable methodology for probabilistic analysis in accordance with NFPA 805. The Revision 1 response to RAI 280.011 and the current revision of the AP1000 Probabilistic Risk Assessment report describe the method used for AP1000. They also describe that the method used may be overly conservative and that additional safety-related function or component based assessments were performed to ensure the design has a very low risk from fire in containment affecting its safety. Although fires in containment represent the largest percentage contributor to CDF, the overall

> CDF itself is acceptably small. No further refinement of the PRA is needed. In many areas of the PRA, more detailed or sophisticated analysis may lead to improvement in the PRA results. It is acceptable to conservatively simplify the PRA analysis.
>
> Westinghouse concludes that AP1000 has met the applicable fire-related regulations, and that no additional fire analysis is required.

The staff reviewed the applicant's response and found it to be acceptable. The FIVE methodology, documented in Appendix 9A to DCD Tier 2, was not used in the fire hazards analysis to justify compliance with the regulatory requirements. Further, the applicant used a deterministic approach based on NFPA 805, Chapter 2, to establish AP1000 fire protection requirements.

The staff finds that the information provided by the applicant satisfies the staff's concern. Therefore, DSER Open Item 9.5.1-2 is resolved.

APPLICABLE NATIONAL FIRE PROTECTION ASSOCIATION CODES, STANDARDS, AND RECOMMENDED PRACTICES

NFPA 10, "Portable Fire Extinguishers"
NFPA 13, "Installation of Sprinkler Systems"
NFPA 14, "Installation of Standpipe and Hose Systems"
NFPA 15, "Water Spray Fixed Systems for Fire Protection"
NFPA 20, "Centrifugal Fire Pumps"
NFPA 22, "Water Tanks for Private Fire Protection"
NFPA 24, "Installation of Private Fire Service Mains and Their Appurtenances"
NFPA 30, "Flammable and Combustible Liquids Code"
NFPA 50A, "Gaseous Hydrogen Systems at Consumer Sites"
NFPA 72, "Protective Signaling Systems"
NFPA 80, "Fire Doors and Windows"
NFPA 90A, "Installation of Air Conditioning and Ventilation Systems"
NFPA 92A, "Recommended Practice for Smoke-Control Systems"
NFPA 204, "Smoke and Heat Venting"
NFPA 251, "Tests of Fire Endurance of Building Construction and Materials"
NFPA 804, "Fire Protection for Advanced Light Water Reactor Electric Generating Plants"
NFPA 805, "Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants"

SUMMARY OF APPROVED DEVIATIONS AND COL ACTION ITEMS FOR THE AP1000

I. Approved Deviations

9.5.1-1	Single failure of primary and backup fire suppression inside containment
9.5.1-2	Cable insulation in concealed spaces of the control room, technical support center, and remote shutdown workstation
9.5.1-3	Definition of safe shutdown for the AP600 and the AP1000

9.5.1-4	Achievement of cold shutdown in 72 hours
9.5.1-5	Breathing air storage tanks located in the auxiliary building
9.5.1-6	Self-contained emergency lighting in the control room and remote shutdown workstation
9.5.1-7	Compliance of PCS tanks with NFPA 22
9.5.1-8	Manual connection between seismic standpipe and yard loop
9.5.1-9	Compliance of PCS recirculation pumps with NFPA 20
9.5.1-10	Dual use of secondary fire water tank
9.5.1-11	Fire department connections to the sprinkler systems
9.5.1-12	Manual operation of standpipe inside containment
9.5.1-13	Containment isolation valves not listed for fire protection service
9.5.1-14	Automatic suppression of peripheral rooms in control room complex
9.5.1-15	Fire detection in MCR cabinets and consoles
9.5.1-16	Fire separation of ancillary diesels
9.5.1-17	Fire detection in DG room (automatic detection not provided in the DG and fuel storage rooms)

II. COL Action Items

9.5.1-1(a)	Fire protection program
9.5.1-1(b)	Implementation of fire protection program
9.5.1-1(c)	Administrative controls
9.5.1-1(d)	Fire brigade
9.5.1-1(e)	Quality assurance program
9.5.1-1(f)	Inspection and maintenance of fire doors, keys for the fire brigade, and marking of exit routes
9.5.1-1(g)	Sampling of water drainage for contamination following a fire
9.5.1-1(h)	Control of combustibles

9.5.1-1(i)	Portable radio communications for the fire brigade
9.5.1-1(j)	Fire protection inside containment during refueling and maintenance
9.5.1-1(k)	Control of combustibles in areas containing safety-related equipment
9.5.1-1(l)	Cooling tower fire protection
9.5.1-1(m)	Storage of welding gas cylinders
9.5.1-1(n)	Storage of ion exchange resins
9.5.1-1(o)	Storage of hazardous chemicals
9.5.1-2	Fire hazard analysis
9.5.1-3	Establishment of fire watches for fire areas breached during maintenance
9.5.1-4	Operator actions minimizing spurious ADS actuation
9.5.1-5	Deviations from NFPA codes and standards
9.5.1-6	Verification of field installed fire barriers
9.5.1-7	Fire resistance test data

9.5.2 Communication Systems

The staff reviewed the AP1000 communication systems in accordance with the SRP Section 9.5.2 acceptance criteria and the guidance in EPRI ALWR utility requirements document (URD). The criteria relies, in part, on the operating history of current plant communication systems. Communication systems are deemed acceptable if the integrated system can provide effective plant personnel communications for a variety of scenarios during normal, incident, and accident conditions and environments. Such environmental considerations include weather, moisture, noise level, and electromagnetic interference/radio-frequency interference (EMI/RFI) conditions which might interfere with the ability for effective communication to be accomplished in all vital areas. Environmental conditions also include fires and radiological events in which personnel must be able to effectively communicate through respiratory protection.

In Title 10 of the Code of Federal Regulations, Section 73.55(e), “Detection Aids,” Section 73.55(f), “Communication Requirements,” and Section 73.55(g), “Testing and Maintenance,” contain design requirements for certain communication systems. These requirements are summarized as follows:

- secondary power supplies for nonportable communications equipment located in vital areas

- on-duty security personnel capable of continuous communication with individuals in manned alarm stations

- use of conventional telephone service

- use of continuous two-way communication in addition to conventional phone via radio or microwave

- nonportable equipment operable in the event of normal power loss

- communications equipment maintained in operable condition

- certain equipment tested on a shift basis or daily, as required by 10 CFR 73.55(g)

Chapter 10, Section 4.6.1, of the URD covers plant operations and maintenance communications, as well as external communications with outside organizations. The communication system designer should include the system requirements and an analysis to ensure the requirements meet the needs of the system. The URD also discusses that the primary and dedicated communication between operations and maintenance personnel should be portable and wireless with the appropriate support equipment. A plant-wide paging system and in-plant telephone system should be included. Dedicated phone links should be included to effect offsite communications.

DCD Tier 2, Section 9.5.2, “Communication System,” contains the description of the communication system. The system consists of the following subsystems:

- wireless telephone system
- telephone/page system
- private automatic branch exchange system
- sound-powered system
- emergency response facility communications
- security communication system

According to the DCD, the private automatic branch exchange (PABX) system and wireless communications fulfill the requirements of 10 CFR 73.55(e) and (f). Communication devices to be used with respiratory equipment shall be designed and selected according to the guidelines of EPRI Report NP 6559, “Voice Communication Systems Compatible with Respiratory Protection.”

The following paragraphs summarize the communication systems described in the DCD.

<u>Wireless Telephone System</u>

The AP1000 wireless telephone system consists of portable handsets and headsets, an antenna system, and wireless phone switch. This is the primary means of plant operations and maintenance personnel communications. The page, PABX phone, and sound-powered systems are backups to the wireless phone system. The system power backup is a UPS that will supply power for up to 2 hours, if normal power is lost.

Auxiliary Systems

Telephone/Page System

The telephone/page system consists of handsets, amplifiers, loudspeakers, tone generators, a test and distribution cabinet, and other support equipment. The system has one paging and five party lines. This allows zone paging, zone to zone paging, and all zone paging. This system is also used for certain alarms designated by the COL applicant. These alarm selections are controlled and programmed from the MCR. Alarm notification will automatically merge the zones for an alarm actuation. The system power backup is a UPS that will supply power for up to 2 hours, if normal power is lost.

Private Automatic Branch Exchange (PABX) System

The AP1000 PABX system provides communications between system stations. This system includes call transfer capability and conference calling. The MCR and TSC have additional capabilities to program selected numbers for particular stations. The PABX interfaces with the wireless phone system, local telephone systems, page system, and direct extensions outside the plant. The system power backup is a UPS that will supply power for up to 2 hours, if normal power is lost.

Sound-Powered System

The AP1000 sound-powered system is used for refueling and for startup and maintenance testing. It does not require an external power supply for operation.

The DCD states that the above-mentioned systems will be tested according to their use. That is, those systems not frequently used will be tested "at periodic intervals to demonstrate operability when required." For those systems that are routinely used, their very use will demonstrate that the system is operating correctly.

As discussed in DCD Tier 2, Section 9.5.2.5, the COL applicant is responsible for the emergency response facility communications and the security communication system. These two systems are discussed below.

Emergency Response Facility Communications

DCD Tier 2, Section 9.5.2.5.2, "Emergency Response Facility Communications," states that the COL applicant will address emergency response facility communications, including the crisis management radio system. This is COL Action Item 9.5.2-1.

Security Communication System

DCD Tier 2, Section 9.5.2.5.3, "Security Communications," states that the COL applicant will provide specific details about the security communication system, as described in DCD Tier 2, Sections 13.6.9 and 13.6.10. These sections state that upon a loss of normal power, the security communication system receives power from the security-dedicated UPS. The UPS is capable of sustaining operation for a minimum of 24 hours. The COL applicant will address specific details of the security communication system, including testing. This is COL Action Item 9.5.2-2.

The staff identified four open items in the DSER which were evaluated as follows:

(1) 10 CFR 73.55(e) and (f) discuss the placement of backup power supplies for certain communication systems in vital areas. This is mentioned in DCD Tier 2, Section 13.6, “Security,” for “vital equipment,” but it is not clear that the applicant considers the “non-portable communication equipment” specified in 10 CFR 73.55(f) to be vital equipment. Open Item 9.5.2-1 in the DSER identified that the DCD should clarify the categorization of communication equipment in accordance with 10 CFR 73.55(f). Westinghouse addressed this open item in a May 14, 2003, RAI response and updated DCD Tier 2, Section 13.6.9 to indicate that the COL applicant will be responsible for the design and design requirements of the backup power supply. This is a part of COL Action Item 9.5.2-2. This response is acceptable to the staff and, therefore, Open Item 9.5.2-1 is resolved.

(2) 10 CFR 73.55(g) discusses testing requirements for certain communication systems. Open Item 9.5.2-2 in the DSER identifies that this issue has not been addressed in DCD Tier 2, Section 9.5.2. Westinghouse addressed this open item in a May 14, 2003, RAI response in which it pointed out that DCD Tier 2, Section 13.5.1 states, in part, that “Combined License applicants referencing the AP1000 certified design will address plant procedures including… maintenance, inspection, test and surveillance.” This is a part of COL Action Item 9.5.2-2. The applicant’s response addressed the staff’s concern regarding the testing of the security communication system and, therefore, Open Item 9.5.2-2 is resolved.

(3) The COL applicant should address the issue of NRC Bulletin 80-15 for recommendations concerning loss of the emergency notification system due to a LOOP. This is COL Action Item 9.5.2-3. Open Item 9.5.2-3 in the DSER recommends including this COL information in the DCD. In its July 7, 2003, RAI response, Westinghouse stated, “DCD Tier 2, [Section] 9.5.2.5.1 will be revised… to remind the COL applicant to review BL 80-15.” The staff verified that the DCD was appropriately revised to reflect COL Action Item 9.5.2-3. This revision to the DCD is acceptable to the staff and, therefore, Open Item 9.5.2-3 is resolved.

(4) SRP Section 9.5.2 provides reviewer guidance on the design of communication systems (i.e., intraplant and plant to off site). Part of that guidance states, “Communication systems will be protected from EMI/RFI effects of other plant equipment and there will be adequate testing and field measurements where necessary to demonstrate effective communications.” In addition, SRP Section 9.5.2 discusses the general requirement for communication equipment to provide effective communication during the “full spectrum of… conditions… under maximum potential noise levels.”

The staff believes that the DCD does not adequately cover communication testing for plant startup and operations in sufficient detail, including the EMI/RFI effects on equipment, to understand how effective communications will be demonstrated. The staff also believes that the DCD does not sufficiently address how effective communications will be sustained during maximum potential noise levels. This is Open Item 9.5.2-4 in the DSER.

In its May 14, 2003, response, Westinghouse stated that DCD Tier 2, Section 14.2.9.4.13 discusses EMI/RFI testing. Westinghouse also stated that:

> test procedures will simulate the predicted worst-case EMI/RFI environment either by operating EMI/RFI producing equipment in the areas of the communication equipment being tested or by simulating the EMI/RFI environment which would result from the predicted worst-case operating configuration of this equipment.

Westinghouse also revised DCD Tier 2, Section 14.2.9.4.13 to address the issue of whether the communication equipment will be able to operate in maximum plant noise levels. The staff finds these responses, and the corresponding revision to the DCD to be acceptable and, therefore, Open Item 9.5.2-4 is resolved.

On the basis of the resolution of the above open items and its review of the design detail provided in the DCD, the staff concludes that the AP1000 communication systems will adequately provide effective communication.

9.5.3 Plant Lighting System

Regulatory Evaluation

The acceptance criteria in SRP Section 9.5.3 state that the acceptability of the design of the normal, emergency, panel, and security lighting is based on the degree to which the system design is similar to the design used in previously approved plants with satisfactory operating experience. No GDC or regulatory guides directly apply to the safety-related performance requirements for the lighting system. The lighting system for the AP1000 should be designed in accordance with SRP Section 9.5.3 and with lighting levels recommended in NUREG-0700, “Guidelines for Control Room Design Review,” which is based on the Illuminating Engineering Society (IES) Lighting Handbook.

Technical Evaluation

The plant lighting system includes normal, emergency, panel, and security lighting. The normal and emergency lighting in the MCR and remote shutdown area are non-Class 1E. The normal lighting provides illumination during plant operating, maintenance, and test conditions. The emergency lighting provides illumination in areas where emergency operations are performed upon loss of normal lighting. The security lighting system is site specific and will be addressed by the COL applicant. This is discussed in Section 13.6.8 of this report.

9.5.3.1 Normal Lighting System

Power to the normal lighting system is supplied from the non-Class 1E power distribution system, and is backed up by the onsite standby DGs. The lighting load is distributed between the two DG buses. The motor control centers, powering the normal lighting system, are energized by the 480-V ac load centers. A lighting control system controls the lighting distribution panel branch circuit breakers. Approximately 75 percent of the normal lighting is tripped off automatically upon loss of normal ac power (except in the MCR and in the remote shutdown area). This limits the load on the onsite DGs. The lighting control system allows an operator to energize or deenergize lighting in selected areas, based on the actual need and available power from the onsite standby DG. The circuits to the individual ac lighting fixtures are staggered, to the extent practical. The staggered circuits are fed from separate buses to ensure that some lighting is retained in the event of a bus or circuit failure. The lighting fixtures located in the vicinity of safety-related equipment are supported so that they do not adversely impact this equipment when subjected to the seismic loading of an SSE.

Power to the normal lighting system is supplied from the non-Class 1E ac power distribution system at the following voltage levels:

- 480/277-V, 3-phase, 4-wire, grounded neutral system lighting panels are fed from the 480-V motor control centers. This source is for the lighting fixtures rated at 480/277 V and for the welding receptacles.

- 208/120-V, 3-phase, 4-wire, grounded neutral system distribution panels are fed from the 480-V motor control centers, through dry-type 480-208/120-V transformers. This source is for the convenience lighting and utility receptacles.

- 208/120-V, 3-phase, 4-wire, grounded neutral regulated power fed from 480-V motor control centers, through the Class 1E 480-208/120-V voltage regulating transformers (Division B and C). This source is for the normal and emergency lighting in the MCR and remote shutdown area, and is isolated through two series of fuses.

The staff considers the information provided to be sufficient to meet SRP Section 9.5.3 and, therefore, is acceptable.

9.5.3.2 Emergency Lighting

Power to the emergency lighting in the MCR and the remote shutdown area is supplied from the Class 1E 125-V dc switchboard through the Class 1E 208Y/120 V ac inverters, and is isolated through two series of fuses. Three-hour barrier separation is provided between redundant emergency power supplies and cables outside the MCR and the remote shutdown area. The control room lighting complies with human factors engineering requirements by using semi-indirect, low-glare lighting fixtures and programmable dimming features. The control room emergency lighting is integrated with the normal lighting, which consists of identical lighting fixtures and dimming features. The emergency lighting system is designed so that, to the extent possible, alternate emergency lighting fixtures are fed from separate divisions of the Class 1E dc and UPS system. Both normal and emergency lighting fixtures, controllers, dimmers, and the associated cables used in the MCR and remote shutdown area are non-Class 1E. The ceiling grid network, raceways, and fixtures utilize seismic supports.

Following the 72-hour period after a loss of all ac power sources, the lighting circuits in the MCR will be powered from two ancillary ac generators.

In areas outside the MCR and the remote shutdown area, emergency lighting is provided by 8-hour, self-contained, battery-pack, sealed-beam lighting units. These units are powered from the non-Class 1E and provide illumination for safe ingress and egress of personnel following a loss of normal lighting in areas that are involved in power recovery. In addition, these units are provided in areas where normal actions are required for operation of equipment needed during a fire. These units are normally powered from the non-Class 1E 480/277-V ac motor control centers.

The staff considers the information provided to be sufficient to meet SRP Section 9.5.3 and, therefore, is acceptable.

9.5.3.3 Panel Lighting

Panel lighting is designed to provide lighting in the MCR at the safety panels. It consists of lighting fixtures located on or nearby the safety panels in the MCR. The panel lights are continuously energized. The fixtures are powered from the Division B and C Class 1E inverters through Class 1E distribution panels. The circuits are treated as Class 1E. The panel lighting circuits up to the lighting fixtures are classified as associated and routed in seismic Category I raceways. The bulbs are not seismically qualified.

The staff has evaluated and determined that the panel lighting design is acceptable because the panel lighting circuits to the lighting fixtures are powered from the Division B and C Class 1E inverters, through Class 1E distribution panels, and are routed in seismic Category I raceways.

9.5.3.4 Conclusions

Based on its review, the staff concludes that the lighting system for the AP1000 is in accordance with SRP Section 9.5.3 and with the lighting levels recommended in NUREG-0700, which is based on the IES Lighting Handbook. Therefore, the design is acceptable.

9.5.4 Standby Diesel Generator Auxiliary Support Systems

There are two redundant onsite standby DG units in the AP1000 design. These will provide power, assuming a single active component failure, to selected non-safety-related ac loads in the event of a loss of normal and preferred ac power supplies. Each standby DG unit is an independent system complete with its necessary support systems that include the following:

- standby DG cooling system
- standby DG starting system
- standby DG lubricating oil system
- standby DG combustion air intake and exhaust system

The standby DGs and their support systems have no safety-related functions and, therefore, have no nuclear safety design basis. They are classified as AP1000 Class D, nonseismic systems, which incorporate standard industrial quality assurance standards to provide appropriate integrity and function. The standby DGs and their support systems are also included in the AP1000 IPSAC and D-RAP programs.

In addition to the two standby DG units, two redundant ancillary ac DGs are located in the annex building to provide long-term backup ac power supplies for postaccident monitoring, MCR lighting, MCR and I&C room ventilation, and PCS and SFP water makeup when all other sources of power are unavailable. The ancillary DGs are not needed for the first 72 hours following a loss of all other ac sources. The ancillary DGs, classified as AP1000 Class D systems, are commercial-grade, skid-mounted, self-contained units packaged with all necessary support systems and controls. The ancillary DGs are also included in the AP1000 IPSAC and D-RAP programs. Section 8.3 of this report presents the staff's evaluation of the ancillary DGs.

9.5.5 Standby Diesel Generator Cooling System

The staff followed the guidance of SRP Section 9.5.5, "Emergency Diesel Engine Cooling Water System," to review the standby DG cooling system in the AP1000 design. The acceptance criteria in SRP Section 9.5.5 are based on meeting the applicable requirements of GDC 2, 4, 5, 17, 44, 45, and 46.

The AP1000 standby DG cooling system serves no safety-related function and, therefore, has no nuclear safety design basis. The system is an independent, closed-loop cooling system, rejecting engine heat through two separate roof-mounted, fan-cooled radiators. The system consists of two separate cooling loops, each maintained at a temperature required for optimum engine performance by separate engine-driven, coolant water circulating pumps. One loop cools the engine cylinder block, jacket, and head area, while the other loop cools the oil cooler and turbocharger aftercooler. The cooling loop, which cools the engine cylinder blocks, jacket, and head areas, includes a keep-warm circuit consisting of a temperature-controlled electric heater and an ac motor-driven water circulating pump.

Based on its review, the staff determined that the standby DG cooling system is a non-safety-related system and serves no safety-related function. Its failure does not lead to the failure of any safety systems. The staff, therefore, concludes that the requirements of GDC 2, 4, 5, 17, 44, 45 and 46, and the guidance of SRP Section 9.5.5, do not apply. In addition, as described in Section 9.5.4 of this report, the standby DG unit, which includes the standby DG cooling system, is classified as an AP1000 Class D system, and is included in the AP1000 IPSAC and D-RAP programs. On the basis of the above information, as well as the fact that its failure does not prevent safe shutdown, the staff finds the standby DG cooling system to be acceptable.

9.5.6 Standby Diesel Generator Starting System

The staff followed the guidance of SRP Section 9.5.6, "Emergency Diesel Engine Starting System," to review the standby DG starting system in the AP1000 design. The acceptance criteria in SRP Section 9.5.6 are based on meeting the applicable requirements of GDC 2, 4, 5, and 17.

The AP1000 standby DG starting system serves no safety-related function and, therefore, has no nuclear safety design basis. The system consists of an ac motor-driven, air-cooled compressor, a compressor inlet air filter, an air-cooled aftercooler, an in-line air filter, a refrigerant dryer, and an air receiver with sufficient storage capacity for three diesel engine starts. In DCD Tier 2, Section 8.3.1.1.2.1, Westinghouse stated that the DG starting system will be consistent with the manufacturer's recommendations regarding the devices to crank the engine, duration of the cranking cycle, the number of engine revolutions per start attempt, volume and design pressure of the air receivers, and compressor size.

Based on its review, the staff determined that the standby DG starting system is a non-safety-related system and serves no safety-related function. Its failure does not lead to the failure of any safety systems. The staff, therefore, concludes that the requirements of GDC 2, 4, 5, and 17, and the guidance of SRP Section 9.5.6, do not apply. In addition, as described in Section 9.5.4 of this report, the standby DG unit, which includes the standby DG starting system, is classified as an AP1000 Class D system, and is included in the AP1000 IPSAC and D-RAP programs. On the basis of the above information, as well as the fact that its failure will not prevent safe shutdown, the staff finds the standby DG starting system to be acceptable.

9.5.7 Standby Diesel Generator Lubricating Oil System

The staff followed the guidance of SRP Section 9.5.7, “Emergency Diesel Engine Lubrication System,” to review the standby DG lubricating oil system in the AP1000 design. The acceptance criteria in SRP Section 9.5.7 are based on meeting the applicable requirements of GDC 2, 4, 5, and 17.

The AP1000 standby DG lubricating oil system serves no safety-related function and, therefore, has no nuclear safety design basis. The system is contained on the engine skid and includes an engine oil sump, a main engine-driven oil pump, and a continuous engine prelube system consisting of an ac and dc motor-driven prelube pump and electric heater. The prelube system maintains the engine lubrication system in service when the DG is in standby mode. The lube oil is circulated through the engine and various filters and coolers to maintain the lube oil properties suitable for engine lubrication.

Based on its review, the staff determined that the standby DG lubricating oil system is a non-safety-related system and serves no safety-related function. Its failure does not lead to the failure of any safety systems. The staff, therefore, concludes that the requirements of GDC 2, 4, 5 and 17, and the guidance of SRP Section 9.5.7, do not apply. In addition, as described in Section 9.5.4 of this report, the standby DG unit, which includes the standby DG lubricating oil system, is classified as an AP1000 Class D system, and is included in the AP1000 IPSAC and D-RAP programs. On the basis of the above information, as well as the fact that its failure will not prevent safe shutdown, the staff finds the standby DG lubricating oil system to be acceptable.

9.5.8 Standby Diesel Generator Combustion Air Intake and Exhaust System

The staff followed the guidance of SRP Section 9.5.8, “Emergency Diesel Engine Combustion Air Intake and Exhaust System,” to review the standby DG combustion air intake and exhaust system in the AP1000 design. The acceptance criteria in SRP Section 9.5.8 are based on meeting the applicable requirements of GDC 2, 4, 5, and 17.

The AP1000 standby DG combustion air intake and exhaust system serves no safety-related function and, therefore, has no nuclear safety design basis. The system provides combustion air directly from the outside to the diesel engine while protecting it from dust, rain, snow, and other environmental particulates. It then discharges exhaust gases from the engine to the outside of the DG building more than 20 feet above the air intake. The combustion air circuit includes weather-protected, dry-type inlet air filters piped directly to the inlet connections of the diesel engine-mounted turbochargers. The engine exhaust gas circuit consists of the engine exhaust gas discharge pipes from the turbocharger outlets to a single vertically mounted outdoor silencer which discharges to the atmosphere. The applicant stated that it considered the manufacturer’s recommendations in the design of features to protect the silencer module and other system components from possible clogging due to adverse atmospheric conditions, such as dust storms, rain, ice, and snow.

Based on its review, the staff determined that the standby DG combustion air intake and exhaust system is a non-safety-related system and serves no safety-related function. Its failure does not lead to the failure of any safety systems. The staff, therefore, concludes that the requirements of GDC 2, 4, 5 and 17, and the guidance of SRP Section 9.5.8, do not apply. In addition, as described in Section 9.5.4 of this report, the standby DG unit, which includes the standby DG combustion air intake and exhaust system, is classified as an AP1000 Class D system, and is included in the AP1000 IPSAC and D-RAP programs. On the basis of the above information, as well as the fact that its failure will not prevent safe shutdown, the staff finds the standby DG combustion air intake and exhaust system to be acceptable.

9.5.9 Diesel Generator and Auxiliary Boiler Fuel Oil System

The staff followed the guidance of SRP Section 9.5.4, “Standby Diesel Generator Fuel Oil Storage and Transfer System,” to review this system. The acceptance criteria in SRP Section 9.5.4 are based on meeting the applicable requirements of GDC 2, 4, 5, and 17.

The AP1000 DG and auxiliary boiler fuel oil system serves no safety-related function and, therefore, has no nuclear safety design basis. The function of the DG and auxiliary boiler fuel oil system is to store and provide fuel oil for the onsite non-safety-related standby DGs, the auxiliary boiler, and the ancillary DGs. The system is designed to provide a supply of fuel oil sufficient to operate each standby DG at a continuous rating for 7 days, provide a 7-day fuel supply for auxiliary boiler operation, with half of the required fuel stored in each tank, and provide a 4-day fuel supply for the two ancillary DGs. The system is classified as an AP1000 Class D system and is included in the AP1000 IPSAC and D-RAP programs.

The DG and auxiliary boiler fuel oil system consists of two independent, full-capacity standby DG fuel oil storage and transfer systems, one for each standby DG (i.e., the auxiliary boiler fuel oil supply system and the ancillary DG fuel oil supply system).

The fuel oil storage tanks for the standby DGs and auxiliary boiler are replenished from trucks (or other mobile suppliers) as required to maintain an adequate fuel supply for the auxiliary boilers and a 7-day fuel supply for each standby DG. Each storage tank is equipped with a vent line to the atmosphere at the top of the tank. This vent line ends with a flame arrester. A tank fill line runs to each tank and is extended to the truck unloading station. The fill line incorporates a normally closed valve and a filler cap at the end to preclude the entrance of water. The fill line is above grade. The fill line has a strainer located downstream of the isolation valve to prevent entrance of deleterious solid material into the tank. A water removal port is located at the tank sump.

Each fuel oil transfer pump takes suction from a fuel oil storage tank and discharges fuel oil to the DG fuel oil day tank. Each pump is capable of supplying its DG and, simultaneously, increasing the inventory in the fuel oil day tank. The fuel oil transfer pump is automatically started and stopped based on day tank level control. Part of the pump discharge flow is returned to the storage tank via the recirculation line. The filter in the discharge line to the day tank is monitored by measuring differential pressures across the filter and by providing a high differential pressure alarm. The fuel oil storage tank for each standby DG also provides fuel oil for the auxiliary boiler. Fuel oil for the standby DG is reserved by tapping auxiliary boiler fuel oil from elevated nozzles above the required DG fuel oil storage level.

In DCD Tier 2, Section 9.5.4.7 Westinghouse states that Combined License applicants referencing the AP1000 certified design will address the site-specific need for cathodic protection in accordance with NACE Standard RP-01-69 for external metal surfaces of metal tanks in contact with the ground. This is COL Action Item 9.5.9-1. Westinghouse also states in DCD Tier 2, Section 9.5.4.7 that Combined License applicants referencing the AP1000 certified design will address site-specific factors in the fuel oil storage tank installation specification to reduce the effects of sun heat input into the stored fuel, the diesel fuel specifications grade and the fuel properties consistent with manufacturers' recommendations, and will address measures to protect against fuel degradation by a program of fuel sampling and testing. This is COL Action Item 9.5.9-2.

Fuel oil to the auxiliary boiler is supplied by two suction supply lines (one from each tank) to two separate fuel oil supply pumping stations. One auxiliary boiler fuel oil pumping station is located in each DG fuel transfer pump enclosure. Both pumps discharge to the auxiliary boiler through a common discharge line. The pumps are full capacity, with one for service and the other as standby. The pump motor and pump are mounted on a common base plate. The system includes a recirculation fuel oil return line from the boiler back to the storage tanks.

The fuel oil storage tank for the ancillary DGs, which consists of a single 100-percent capacity tank serving both ancillary DGs, is replenished from trucks (or other mobile suppliers) as required to maintain a 4-day fuel supply for both DGs. The ancillary DG fuel oil storage tank is seismic Category I and is located in the same room as the generators.

Based on its review, the staff determined that the DG and auxiliary boiler fuel oil system is a non-safety-related system and serves no safety-related function. Its failure does not lead to the failure of any safety systems. The staff, therefore, concludes that the requirements of GDC 2, 4, 5 and 17, and the guidance of SRP Section 9.5.4, do not apply. In addition, as described above, the DG and auxiliary boiler fuel oil system is classified as an AP1000 Class D system, and is included in the AP1000 IPSAC and D-RAP programs. On the basis of the above information, as well as the fact that its failure will not prevent safe shutdown, the staff finds the DG and auxiliary boiler fuel oil system to be acceptable.