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No figures were included in these sections.

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9 AUXILIARY SYSTEMS

9.2 Water Systems

The U.S. EPR contains several major cooling water systems including the essential service water system (ESWS), component cooling water system (CCWS), safety chilled water system, and ultimate heat sink (UHS).

9.2.1 Essential Service Water System

9.2.1.1 *Introduction*

The ESWS provides the assured means of cooling essential plant equipment and removing decay heat from the reactor and the spent fuel pool. The ESWS is comprised of four mechanically and electrically independent safety-related divisions and one dedicated non-safety-related division for severe accident management. Each division consists of an ESWS pump, a filter piping (to the associated heat loads), valves, controls, and instrumentation. Each safety-related ESWS division is nominally rated for 50 percent capability and removes heat from its respective CCWS heat exchanger (HX), emergency diesel generator (EDG) cooler, and ESWS pump room cooler. The dedicated (non-safety-related) ESWS division removes heat from its respective CCWS HX and can be aligned to remove heat from the Division 4 ESWS pump room cooler (the dedicated ESWS pump is located in the Division 4 pump room). A separate mechanical draft cooling tower is used as the UHS for each safety-related ESWS division (see Section 9.2.5 of this report for an evaluation of the UHS) and rejects heat from the ESWS to the environment. The non-safety-related dedicated ESWS division uses the Division 4 cooling tower as its UHS. Each safety-related division is powered by an ASME Code Class 1E electric bus with emergency power from its associated EDG. The dedicated ESWS division is also powered by the Division 4 ASME Code Class 1E electric bus and receives emergency power from the station blackout (SBO) EDG.

Except for confirming that the dedicated ESWS will not adversely impact the capability of the safety-related ESWS to perform its safety functions, evaluation of the dedicated ESWS is not included within the scope of this evaluation. Section 19.2 of this report provides an evaluation of the dedicated ESWS division as well as other severe accident management considerations.

9.2.1.2 *Summary of Application*

FSAR Tier 1: FSAR Tier 1 information for the ESWS is provided by Final Safety Analysis Report (FSAR) Tier 1, Section 2.7.11, "Essential Service Water System," which includes functional arrangement drawing Figure 2.7.11-1, "Essential Service Water System Functional Arrangement." Mechanical design information is provided in FSAR Tier 1, Table 2.7.11-1, "Essential Service Water System Equipment Mechanical Design," which provides valve and pump physical location, function, American Society of Mechanical Engineers (ASME) Section III applicability, and seismic category. With the exception of components associated with the non-safety dedicated ESWS division, all items in Table 2.7.11-1 are identified as ASME Section III and Seismic Category 1. An interface item is also identified in Section 2.7.11, Paragraph 8.1 to provide site-specific emergency basin water makeup.

FSAR Tier 2: FSAR Tier 2, Section 9.2.1, "Essential Service Water System," describes the ESWS. The ESWS is shown in FSAR Tier 2, Figure 9.2.1-1, "Essential Service Water System Piping & Instrumentation Diagram." Each safety-related ESWS division consists of one ESWS pump, a debris filter, HX, piping, valves, controls, and instrumentation.

The principal components of the ESWS are housed in four independent, safety-related, Seismic Category I, Essential Service Water Buildings (ESWBs). As described in FSAR Tier 2, Section 3.8.4.1.5, "Essential Service Water Building," each ESWB houses an essential service water cooling tower structure and an attached Essential Service Water Pump Building. The four buildings are located in pairs on each side of the Nuclear Island (NI) complex. The pairs of buildings are physically separated to protect them from being simultaneously affected by external events such as aircraft hazards and explosion pressure waves.

Initial plant testing of the ESWS is described in FSAR Tier 2, Section 14.2.12.5.7, "Essential Service Water System (Test #048)."

ITAAC: Inspections, tests, analyses, and acceptance criteria (ITAAC) for the ESWS are shown in FSAR Tier 1, Table 2.7.11-3, "Essential Service Water System ITAAC."

Technical Specifications: Technical Specifications (TS) for the ESWS are as described in FSAR Tier 2, Chapter 16, "Technical Specifications," TS Section 3.7.8, "Essential Service Water (ESW) System."

9.2.1.3 *Regulatory Basis*

The relevant requirements of NRC regulations for this area of review, and the associated acceptance criteria, are given in NUREG-0800, Section 9.2.1, "Station Service Water System," Revision 5, March 2007, and are summarized below. Review interfaces with other SRP sections also can be found in NUREG-0800, Section 9.2.1.

1. General Design Criterion (GDC) 2, "Design Basis for Protection Against Natural Phenomena," as it relates to the capabilities of structures housing the system and the system itself having the capability to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, floods, tsunami, and seiches without loss of safety-related functions.

2. GDC 4, "Environmental and Dynamic Effects Design Bases," as it relates to effects of missiles inside and outside containment, effects of pipe whip, jets, environmental conditions from high- and moderate-energy line-breaks, and dynamic effects of flow instabilities and attendant loads (e.g., water-hammer) during normal plant operation, as well as upset or accident conditions.

3. GDC 5, "Sharing of Structures, Systems, and Components," insofar as it requires that SSCs important to safety not be shared among nuclear power units unless it can be shown that sharing will not significantly impair their ability to perform their safety functions.

4. GDC 44, "Cooling Water," as it relates to the capability to transfer of heat from systems, structures, systems, and components important to safety to an ultimate heat sink during both normal and accident conditions, with suitable redundancy, assuming a single active component failure coincident with either the loss of offsite power or loss of onsite power.

5. GDC 45, “Inspection of Cooling Water System,” as it relates to design provisions for inservice inspection of safety-related components and equipment.

6. GDC 46, “Testing of Cooling Water System,” as it relates to design provisions for pressure and operational functional testing of cooling water systems and components in regard to

   - o Structural integrity and system leak-tightness of its components
   - o Operability and adequate performance of active system components
   - o Capability of the integrated system to perform credited functions during normal, shutdown, and accident conditions

7. 10 CFR 52.47, “Contents of applications; technical information,” Item (b)(1), which requires that a design certification application contain the proposed ITAAC that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a facility that incorporates the design certification has been constructed and will be operated in accordance with the design certification, the provisions of the Atomic Energy Act, and NRC regulations.

8. 10 CFR 20.1406, “Minimization of Contamination,” as it relates to the standard plant design certifications and how the design and procedures for operation will minimize contamination of the facility and the environment facilitate eventual decommissioning and minimize to the extent practicable, the generation of radioactive waste.

Acceptance criteria adequate to meet the above requirements include:

- RG 1.29, “Seismic Design Classification,” March 2007, (Seismic Design Criteria), Regulatory Position C.1 for safety-related and Regulatory Position C.2 for non-safety-related portions of the ESWS.

- Generic Letter (GL) 96-06, “Assurance of Equipment Operability and Containment Integrity During Design-Basis Accident Conditions,” (including Supplement 1).

9.2.1.4 *Technical Evaluation*

The staff evaluation of the ESWS is based upon the information provided in the applicant’s February 19,2011, response to RAI 465, Question 09.02.01-51, which transmitted FSAR Tier 2 FSAR markups for Section 9.2.1, Interim Revision 3 and in other FSAR sections as discussed below.

The staff requested that the applicant respond to questions in 52 RAIs that were based on the information in FSAR Tier 2, Revisions 0, 1, and 2 that described the design, operation, and testing of the ESWS. The applicant answered these questions in numerous responses that included FSAR markups which the staff has reviewed and finds acceptable because, in RAI 465 Question 09.02.01-51, the staff requested that the applicant compile and submit an FSAR markup that incorporated all the FSAR markups that were submitted separately as part of the responses to the 52 RAIs. In a February 19, 2011, response to RAI 465, Question 09.02.01-51, the applicant provided an Interim FSAR Revision 3 markup for the applicable sections.
The staff reviewed the FSAR Interim Revision 3 mark-up and confirmed that all of the ESWS RAI response markups had been successfully incorporated into it. In this report, the staff is not

describing each staff RAI and the information the applicant provided in response to each RAI; rather, the staff's technical evaluation below is based on the staff's review of the interim FSAR Revision 3 markup for the applicable sections, which includes all the information submitted in response to the original 52 staff RAIs. In some cases, the staff may discuss the applicant's RAI responses where clarifying information which is not described in the FSAR to ensure that information is ultimately included in the FSAR, RAI 465, Question 09.02.01-51 is being tracked as a confirmatory item.

9.2.1.4.1 System Design Considerations

GDC 2 and RG 1.29

The ESWS must be capable of withstanding the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, floods, and external missiles without loss of capability to perform its safety functions in accordance with GDC 2 requirements. Analyses, design features, and provisions that are credited for satisfying GDC 2 requirements are described in FSAR Tier 2, Chapter 3 sections that address the specific hazards considerations; and the staff's evaluations of these analyses, design features, and provisions are provided in Sections 3.2 through 3.11 of this report, which correspond to the SSCs relied upon for the ESWS to meet GDC 2.

FSAR Tier 2, Section 3.2, "Classification of Structures, Systems, and Components," specifies the classification of structures, systems, and components based on safety importance and other considerations. Based on the criteria specified in FSAR Tier 2, Section 3.2, essential parts of the ESWS should be designated as safety-related, Seismic Category I, Quality Group C and controlled in accordance with 10 CFR Part 50, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," requirements. The staff reviewed the piping and instrumentation diagrams (P&IDs) for the ESWS and determined that essential parts of the system (including boundary isolation valves) are properly designated as safety-related, Seismic Category I, Quality Group C and that non-essential parts are properly designated as non-safety-related. The staff confirmed that this information is correctly reflected in FSAR Tier 2, Table 3.2.2-1, "Classification Summary," Sheets 93 through 97, and that 10 CFR Part 50, Appendix B requirements are appropriately specified for the safety-related parts of the system.

FSAR Tier 2, Section 9.2.5.3.3, "Cooling Tower Basin," describes leakage rates for boundary isolation valves that require testing are based on ASME OM Code to support the first 72 hrs of post-accident UHS cooling tower operation. The cooling tower basis is described further in Section 9.2.5 of this report.

Valve seat leak testing (LT) is specified for these ESWS boundary isolation valves 30PEB10/20/30/40 AA003 (emergency blowdown), 30PEB10/20/30/40 AA015 (filter blowdown), 30PEB10/20/30/40 AA016 (normal blowdown) in the inservice valve testing program described in FSAR Tier 2, Table 3.9.6-2, "Inservice Valve Testing Program Requirements."

Non-seismic lines and associated equipment are routed, to the extent possible, outside of safety-related structures and areas to avoid potentially adverse interactions. In the event that this routing is not possible and non-seismic lines must be routed in safety-related areas, the non-seismic items are evaluated for seismic interactions as described in FSAR Tier 2, Section 3.7.3.8, "Interaction of Non-Seismic Category I Subsystems."

FSAR Tier 2, Table 3.2.2-1 (Revision 2, Sheet 95) indicates that some of the safety-related parts of the ESWS are located in outside areas. FSAR Tier 2, Section 9.2.1.1, "Design Bases," states that the ESWS structures, systems, and components that provide essential cooling for safety-related equipment are designed to withstand the effects of natural phenomena, and safety-related portions of the ESWS are designed to accommodate the effects of and to be compatible with the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents. Outdoor safety-related portions of the ESWS are located underground and the safety-related ESW divisions are physically separated from one another, as well as from structures and components in other systems, to preclude any adverse interactions. Safety-related ESWS duct banks and supply and return piping between buildings are indicated with the location designation, "UZT," which identifies outdoor areas. In a March 27, 2009, response to RAI 119, Question 09.02.01-3, the applicant further clarified that these SSCs are buried at a sufficient depth to protect the piping from freezing, as well as to shield the piping and duct banks from the effects of natural phenomena. FSAR Tier 1, Section 4.0, "Interface Requirements" also addresses, in Section 4.6, "Buried Conduit and Duct Banks and Pipe and Pipe Ducts," the requirements for protection of buried piping and duct banks from natural phenomena and other design considerations such as flooding and freezing.

FSAR Tier 2, Section 3.7.3.8.2, "Interaction Evaluation," states that non-seismic SSCs may be located in the vicinity of safety-related SSCs without being qualified as Seismic Category II provided an impact evaluation is performed to verify that no possible adverse impacts occur. In this report, the non-seismic components are assumed to fall or overturn as a result of a seismic event. Any safety-related subsystem or component which may be impacted by the non-seismic component is identified as an interaction target and is evaluated to establish that there is no loss of ability to perform its safety-related function. Section 3.7 of this report further describes an FSAR Tier 1, ITAAC. The ITAAC is intended to verify via as-built inspection of non-safety-related SSCs in the plant that non-safety-related SSCs will not reduce the function of safety-related SSCs during and after a safe-shutdown earthquake.

The staff has confirmed that the safety- and non-safety-related parts of the ESWS are properly classified, such that the analyses, design features, and provisions described in FSAR Tier 2, Chapter 3 will ensure that the ESWS is capable of performing its safety functions during severe natural phenomena, as follows.

The safety-related portions of ESWS will withstand the effects of several natural phenomena, since the safety-related SSCs are either located inside buildings designed to withstand the conditions presented by severe natural phenomena postulated in FSAR Tier 2, Chapter 2, Site Characteristics or the safety-related SSCs are themselves designed (buried piping) to withstand the severe natural phenomena.

The design of these SSCs conforms to the guidance provided in RG 1.29. Also, because each of the safety-related ESWS divisions has its own safety-related emergency power source which is protected from the effects of natural phenomena as described in FSAR Tier 2, Chapter 3, Design of Structures, Components, Equipment and Systems.

Therefore, the staff finds that the design of the ESWS meets GDC 2, with respect to being capable of withstanding the effects of natural phenomena without loss of capability to perform its safety functions, since RG 1.29, Regulatory Position C.1 for safety-related portions of the ESWS, and RG 1.29, Regulatory Position C.2 for the non-safety-related portions of the ESWS have been adequately addressed.

GDC 4, "Environmental and Dynamic Effects Design Bases"

The ESWS must be adequately protected from dynamic effects due to equipment failures, including those due to external environmental conditions and must be capable of performing its safety functions over the entire range of environmental conditions associated with normal operations, maintenance, testing, and postulated accident, in accordance with GDC 4 requirements. Analyses, design features, and provisions that are credited for satisfying GDC 4 requirements are described primarily in FSAR Tier 2, Sections 3.4, "Water Level (Flood) Design)," 3.5, "Missile Protection," 3.6, "Protection against Dynamic Effects Associated with Postulated Rupture of Piping," and 3.11, "Environmental Qualification of Mechanical and Electrical Equipment"; and the staff's evaluations of these analyses, design features, and provisions are provided in the corresponding sections of this report. As discussed above in FSAR Tier 2, Section 9.2.1.4.1, "GDC 2 and RG 1.29," the staff has confirmed that the safety and non-safety-related parts of the ESWS are properly classified such that the analyses, design features, and provisions described in FSAR Tier 2, Sections 3.4, 3.5, 3.6, and 3.11 will ensure that the ESWS is adequately protected from dynamic effects and capable of performing its safety functions over the entire range of environmental conditions contemplated in GDC 4.

Also, the staff reviewed the information in FSAR Tier 2, Table 3.6.1-1, "High-Energy and Moderate-Energy Fluid Systems Considered for Protection of Essential Systems," to confirm that the proper designation of "moderate energy" as given for ESWS is correct. For ESWS, the design pressure/temperatures are 1,310 kPa (gauge)/57.2 °C (190 psig/135 °F) and for the dedicated ESWS, the design pressure/temperatures are 689.5 kPa (gauge)/65.6 °C (100 psig/150 °F). The staff confirmed that both systems are correctly classified, since they are both below 93.3 °C (200 °F) and a gauge pressure of 1,896 kPa (275 psig).

Additionally, GDC 4 requires safety-related SSCs to be able to accommodate the effects of discharging fluids resulting from postulated pipe failures. The general protection concept in case of pipe failures in the ESWS and resulting flooding is based on limiting the consequences to the affected division. FSAR Tier 2, Section 3.4.3.4, "Safeguard Buildings Flooding Analysis," includes discussion of a postulated ESWS flooding scenario in a Safeguard Building with the potential to extend above elevation zero where impact could occur to more than one division. FSAR Tier 2, Section 3.4.3.4 also states that to cope with this scenario, the ESWS pump must be stopped, and the isolation valve in the discharge line of the affected ESWS division must be closed to limit the flooding volume to the affected Safeguard Building. FSAR Tier 2, Section 3.4.3.4 also describes that a postulated pipe break or erroneous valve alignment in the ESWS has the potential to impact more than one division. In case of an ESWS significant flooding event in a Safeguard Building, the associated ESWS pump discharge isolation valve is automatically closed, the ESWS pump is tripped, and another ESWS division is also put into operation. Automatic isolation of the discharge valve and stopping of the ESW pump are intended to restrict the released flood water volume in the affected Service Building and to prevent the resulting internal water level from rising above the maximum allowed elevation of 0 m (+0 ft). According to the applicant, detection and isolation signaling is performed by safety-related means and is part of the nuclear island drain/vent system (NIDVS) sump level instruments in the uncontrolled areas of the Service Building, see U.S. EPR FSAR Tier 2, Figure 9.3.3-1, "Nuclear Island Drain and Vent System"). These controls are supplied by ASME Code Class 1E power and are Seismic Category I. Each sump is equipped with two level instruments, and actuation of one of the two (1 of 2 logic) will provide a MAX alarm in the main control room and isolate the affected division. No operator action is credited to isolate the ESWS in a large flooding event. In addition, for flooding in the Safeguard Building, FSAR Tier 2, Section 3.4.3.4 states that a control room alarm is provided for the ESWS pump trip. The main control room (MCR) alarms associated with this flood protection design feature are provided by instrumentation described in FSAR Tier 2, Section 9.3.3.3, “Safety Evaluation,” and is not part of the ESWS. To cope with a large flooding event, the NIDVS sump located in the lowest level of the uncontrolled area of each Safeguard Building is equipped with safety-related level instrumentation to automatically trip the ESWS pumps and close the associated discharge isolation valve. The level set point which initiates ESW isolation via the NIDVS safety-related sensors is above the floor.

The staff determined that these flooding controls and related instrumentations were safety-related, Seismic Category I and provided with ASME Code Class 1E power, and no operator actions are necessary for ESWS isolation in the event of a significant flood in a Safeguard Building.

The ESWS description was reviewed to confirm that the applicant has adequately addressed water hammer considerations. Two of the four safety-related divisions are normally in operation with the remaining two divisions in standby. All valves in the main flow path of each division, including the two divisions in standby, are maintained open (FSAR Tier 2, Section 9.2.1.4, “Operation”). Since the cooling tower spray nozzles are located at an elevation that is well above the cooling tower basin water level, there is a potential for the standby loops to drain to their respective cooling tower basins and create a large air void in the piping of the ESWS standby divisions. If this occurs, an automatic actuation of the standby ESWS divisions could result in a water hammer. Any loop seals in the ESWS that are caused by component design or piping configuration would tend to result in a much more severe water hammer event. The applicant provided the following system description and analysis FSAR Tier 2, Section 9.2.1.3.5, “Piping, Valves, and Fittings,” describes the operational and design features for water hammer prevention and mitigation. These design features include air release valves, vacuum breakers valves, and a keep full system which are described below.

The ESW pump is started against a closed discharge isolation valve 30PEB10/20/30/40 AA005. Air release valve 30PEB10/20/30/40 AA190 provides a path to remove the air in the pipe between the debris filter and the pump. In addition, following a trip of the pump, the air release valves provide a path for air to enter the ESW line to prevent vacuum formation.

Vacuum breaker valve 30PEB11/21/31/41 AA191 as shown in FSAR Tier 2, Figure 9.2.1-1 provides a path for air to fill the room cooler discharge line when the ESW pump trips. The discharge line from the room cooler is submerged in the basin. Following a trip of the pump, as the water in the vertical section of the room cooler discharge line drains to the basin, the vacuum breaker valve provides a path for the air to prevent vacuum formation.

Monitoring of the water level in the tower riser pipe of a standby division is administratively controlled to keep the water level in the riser above the predetermined minimum. The non-safety-related keep-fill line delivers water from the normal makeup supply to the top of the UHS tower riser pipe through a manually operated safety-related boundary isolation valve 30PEB10/20/30/40 AA024 and check valve 30PEB10/20/30/40 AA025. Level in the tower riser is can be monitored by the control room operators, since level indication (with Min 1 and Min 2 alarms) is provided in the MCR and locally at the keep-fill valve. The non-safety-related function of the tower keep-fill line is to permit the field operator a means to replenish water in the cooling tower riser pipe that is lost due to leakages in the system, thereby minimizing potential water hammer effects during division startup due to air voids in the piping. The safety-related manual keep-fill valve and check valve separates the non-safety-related portions of the keep-fill line to maintain the pressure boundary of the safety-related riser pipe. This design provision eliminates the need for the start of the whole division by operator action. Even with the design features described above, in FSAR Tier 2, Section 9.2.1.3.5, the applicant has committed to performing a hydraulic transient analysis to confirm the integrity of ESW piping to withstand the effects of water hammer.

The staff finds that the prevention of water hammer events and mitigation has been adequately addressed by the applicant, since a keep-fill line and monitoring of water level in the tower riser pipe of a standby division is administratively controlled to keep the water level in the riser above the pre-determined minimum. The pump discharge isolation valves 30PEB10/20/30/40 AA005 automatically close on pump stop; therefore, the leakage path from the tower riser is through the pump discharge isolation valve, and the pump discharge check valve 30PEB10/20/30/40 AA204, all in series. Valve seal leak testing has been specified for motor operated valves (MOVs) 30PEB12/20/30/40 AA005 (ESWS pump discharge), 30PEB12/20/30/40 AA010 (cooling tower isolation valves), and the pump discharge check valve 30PEB12/20/30/40 AA204 in the inservice valve testing program in FSAR Tier 2, Table 3.9.6-2. In addition, air release valves automatically provide a path to remove the air in the pipe during ESWS pump starts.

Accordingly, the staff finds that the design of the ESWS has met GDC 4, since the ESWS is adequately protected from dynamic effects due to equipment failures and external environmental conditions and is capable of performing its safety functions over the entire range of environmental conditions associated with normal operation, maintenance, testing, and postulated accidents. In the event of a breach of one loop of ESWS, the consequence of flooding is limited due to ESWS pump trip and isolation of the affected division. The applicant has agreed to perform a hydraulic transient analysis to confirm the integrity of ESW piping to withstand the effects of water hammer. In addition, the staff finds that the ESWS water hammer has been adequately addressed in the FSAR with respect to GDC 4.

GDC 5, “Sharing of Structures, Systems, and Components”

The applicant must demonstrate that the sharing of SSCs between nuclear power units will not significantly impair the capability of the ESWS to perform its safety functions in accordance with GDC 5 requirements. The U.S. EPR standard plant design is a single-unit station and, consequently, there are no shared safety-related SSCs between different units. Therefore, the provisions of GDC 5 are not applicable to the U.S. EPR standard plant design.

GDC 44, “Cooling Water”

The ESWS must be capable of transferring heat from SSCs important to safety to an ultimate heat sink (UHS) during normal operating and accident conditions over the life of the plant in accordance with GDC 44. Furthermore, in FSAR Tier 2, Sections 1.2.3.1.1, “Overview,” 3.1.4.15.1, U.S. EPR Compliance,” 9.2.1.2, “System Description,” and 9.2.1.4.2, “Abnormal Operating Conditions Non-LOCA Design Basis Event During Power Operation,” the applicant states that each safety-related division is a functional part of the overall U.S. EPR four safety-division design. This design provides sufficient redundancy for the ESWS to perform its intended safety functions in the event of a single failure of one safety division with a second division out of service for maintenance, as described below.

The following ESWS design considerations were evaluated to determine if the ESWS is capable of performing its functions in accordance with this requirement:

- Descriptive Information

The staff reviewed the ESWS description and P&ID to confirm that the flow paths and components have been identified and described in sufficient detail to enable a full understanding of the system design and operation, including a clear distinction between the safety-related and non-safety-related parts of the system.

Piping flow velocities are specified in FSAR Tier 2, Section 9.2.1.3.5 and limited to 3.05 m per sec (10 ft per sec). As stated in FSAR Tier 2, Tables 9.2.1-1, “Essential Service Water Design Parameters,” and 9.2.1-2, “Dedicated Essential Service Water Design Parameters,” the design pressure and temperature of the ESWS is 13.3 kg/cm^2/57.2 °C (190 psig/135 °F) and the design pressure and temperature of the dedicated ESWS is 7.0 kg/cm^2/65.6 °C (100 psig/150 °F). The staff finds that these are reasonable design values, since they are consistent with the design values for the service water systems at existing nuclear power plants, which have typically performed without excessive long term pipe wall thinning at these piping flow velocities.

FSAR Tier°2, Section 9.2.1.7, “Instrumentation Requirements” addresses the details of the ESWS safety-related instrumentation and control (I&C) functions. These functions are addressed in FSAR Tier°2, Section 9.2.1.7, “Instrumentation Requirements,” which include the automatic actions as a result of a safety injection (SI), automatic actions at the start of a component cooling water division, automatic actuation of ESW from a loss of offsite power (LOOP), and other manual ESW actuations that are backups to automatic actuations. In addition, ESWS pump trips, which include high bearing temperature, high differential pressure across the debris filter, low pump discharge flow, high discharge pressure, or cooling tower basin low level, and a detailed alarm summary are provided in FSAR Tier 2, Table 9.2.1-3, “Alarm Summary.” The staff finds that set point descriptions have been adequately addressed in the FSAR with sufficient details for important alarms and automatic actions.

FSAR Tier 2, Sections 9.2.1.7.1, “System Monitoring,” and 9.2.1.7.2, “System Alarms,” describe the available instruments utilized for ESWS monitoring. They include ESWS flow rates, ESWS temperatures, MOV position status, and ESWS strainer differential pressures. Indication of the ESW pump building room temperature is provided in the MCR as stated in FSAR Tier 1, Table 2.6.13-2, “Essential Service Water Pump Building Ventilation System Equipment I&C and Electrical Design.” ESW temperature measurements are provided at the discharge of the ESWS pumps and downstream of the pump building ventilation system room coolers. Differential pressure (DP) across the pump room cooler and ESWS water temperature indications are available in the MCR; therefore, plant operators will have information related to possible ESW degraded flow rates or degraded heat exchanger performance. DP is also available locally.

FSAR Tier 2, Section 9.2.1.3.5 describes important ESWS valve functions. For example, the minimum flow recirculation line is provided to protect the associated ESWS pump from overheating, and the flow path is established when the ESWS pump minimum flow recirculation isolation valve opens due to failure of the ESWS pump discharge isolation valve to open on pump start.

FSAR Tier 2, Section 9.2.1.3.5 describes normal blow down flow from the ESWS to the plant waste water retention basin which is established when the ESW normal blow down isolation valve is opened. In addition, an emergency blow down path is provided in the event that the normal blow down path becomes unavailable. The purpose of both lines is to maintain cooling tower water chemistry.

FSAR Tier 2, Sections 9.2.1.7.1, “System Monitoring,” and 9.2.1.7.2, “System Alarms,” describe the available instruments utilized for ESWS monitoring. They include ESWS flow rates, ESWS temperatures, MOV position status, and ESWS strainer differential pressures. Indication of the ESW pump building room temperature is provided in the MCR as stated in FSAR Tier 1, Table 2.6.13-2, “Essential Service Water Pump Building Ventilation System Equipment I&C and Electrical Design.” ESW temperature measurements are provided at the discharge of the ESWS pumps and downstream of the pump building ventilation system room coolers. Differential pressure (DP) across the pump room cooler and ESWS water temperature indications are available in the MCR; therefore, plant operators will have information related to possible ESW degraded flow rates or degraded heat exchanger performance. DP is also available locally.

In summary, the staff finds that the ESWS descriptive information which includes P&IDs, pipe flow velocities, I&C functions/description, and valves functions, has been adequately addressed in the FSAR with sufficient details to support heat transfer to the UHS assuming a single active failure coincident with LOOP with the capability to isolate SSCs as required so that the ESWS function will not be compromised.

- Heat Transfer and Flow Requirements

The staff reviewed the ESWS FSAR design description to confirm that the heat transfer and minimum system flows are adequately specified, that the bases for these values are fully explained, and that limiting system temperatures and pressures are specified and explained.

The maximum heat loads specified in FSAR Tier 2, Table 9.2.5-1, “Ultimate Heat Sink System Interface,” are bounding for the operating modes. The ESW pumps are sized to provide the capacity to support system flow to transfer heat from the CCWS, EDG heat exchangers (which include the intercooler loop heat exchanger, lube oil cooler, and jacket water heat exchanger in series) and ESW pump building ventilation system room coolers to the environment during normal operating and accident conditions. The pumps are sized to meet the design flow credited in the design-basis accident (DBA) mode with EDGs operating, which is the largest heat load that would be placed on the system. Margin is described in FSAR Tier 2, Section 9.2.1.3.1, “Safety-Related Essential Service Water Pumps,” for both the minimum flow and the minimum ESW pump head as shown below.

The bases for the pump head and pump design flow margin were provided in a November 4, 2010, response to RAI 345, Question 09.02.01-32. Pump head margin is 10 percent which is based on four percent pump wear, two percent instrument uncertainty, four percent frequency variation, and one and one-half percent system balance. Pump design flow margin is 12.5 percent which is based on 8 percent pump wear, 2 percent instrument uncertainty, 2 percent frequency variation, and system flow balance one and one-half percent.

The staff reviewed the margin which is calculated using the sum of the squares method to prevent system over design. The total margin is calculated by adding the pump wear margin and the system balance margin to the sum of the squares of the other margins (instrument uncertainty and frequency variations). This way the collective margin will account for transients in pump wear, plant testing instrument uncertainty, and frequency variation. The staff concludes that the margin used for both the ESWS head and flow margins are reasonable and acceptable based on industry practice and operating experiences to permit SSCs degradation over time.

The staff was able to obtain agreement with the total dynamic head (TDH) value specified in FSAR Tier 2, Table 9.2.1-1 of 56.4 m/H2O (185 ft/H2O) for the safety-related ESWS pumps as follows. The staff used the hydraulic resistance values provided by the applicant in a March 27, 2009, response to RAI 119, Question 09.02.01-6, in conjunction with an estimate of the credited lift elevation from the minimum water level in the cooling tower basin to the spray nozzles taken from FSAR Tier 2, Figure 3.8-101, "Essential Service Water Building Section B-B."

With respect to ESWS flow, FSAR Tier 2, Table 9.2.1-1 states that the safety-related ESWS pump normal flow rate is 73.2 m^3/min (19,340 gpm) at 0.55 MPa (185 ft) of water. Each ESWS division includes parallel connected flow paths to one CCWS HX, one EDG, and an ESW pump room cooler. ESWS flow is continuously supplied to all components for both normal and accident conditions. FSAR Tier 2, Table 9.2.5-1 indicates that nominal CCWS HX mass flow is 3.42×10^6 Kg/hr (7.54×10^6 lbm/hr), EDG flow is 0.48×10^6 Kg/hr (1.06×10^6 lbm/hr), and ESWS pump room cooler is 0.031 Kg/hr (0.0685 lbm/hr). Converting to should be liters/min (gpm), there is approximately 8,325 l/min (2,200 gpm) of flow margin between the normal ESWS pump normal flow rate and the total minimum ESWS flow rates needed to remove heat from the CCWS, EDG, and ESW room cooler.

Accordingly, the staff finds that the ESWS heat transfer and flow capabilities have been adequately addressed in the FSAR in accordance with GDC 44.

- Single Failure

The ESWS must be capable of performing its safety functions assuming a single failure with onsite power (assuming offsite power is not available) and with offsite power available (assuming onsite power is not available) in accordance with GDC 44 requirements. Only two ESWS divisions are needed for accident mitigation, and the four division ESWS design therefore provides complete redundancy. FSAR Tier 2, Section 9.2.1.5, "Safety Evaluation," describes that each division of the ESWS is independent of any other division, and no components are shared between divisions. Also, upon a loss-of-offsite power, each ESWS division receives power from its respective EDG. Therefore, a single failure, either loss of off-site with loss of a EDG or loss of an on-site divisional bus, will only affect one division and will not compromise the capability of the ESWS to perform its safety functions with and without offsite power available. Additionally, the four safety division design provides sufficient redundancy such that design-basis accident mitigation capability is maintained in the event that there is a failure associated with one division with another division out of service for maintenance.

Accordingly, the staff finds that the ESWS single failure considerations have been adequately addressed in the FSAR in accordance with GDC 44.

- ESWS Pump Net Positive Suction Head

In order to satisfy system flow requirements, the ESWS design must assure that the minimum net positive suction head (NPSH) for the ESWS pumps will be met for all postulated conditions, including consideration of vortex formation.

FSAR Tier 2, Table 9.2.1-1 describes 2.41 m (94.88 in.) above the suction inlet as the minimum water level in the UHS basin for NPSH and vortex suppression. In addition, FSAR Tier 2, Figure 9.2.5-3, describes the cross-section of the UHS tower basin with respect to ESWS pump submergence. The assumption used for calculating available NPSH is that the system fluid is water at the maximum design UHS outlet water temperature (35 °C (95 °F)) during a design-basis accident. This temperature is bounding for the basin water temperature after 72 hrs following a DBA which is stated in the applicant's response to RAI 345, Q 09.02.01-41.

In a July 20, 2010 and November 4, 2011, response to RAI 345, Question 09.02.01-34, the applicant stated that net positive suction head (NPSHA) available at sea level is calculated to be 9.87 m (32.4 ft of water) after the first 72 hrs following a DBA. At elevation 305 m (1,000.66 ft), the NPSHA1000 is calculated to be 9.51 m (31.20 ft of water) after the first 72 hrs following a DBA. In an April 27, 2009, to RAI 119, Question 09.02.01-8 that the pump design sizing assumes maximum reduction in available NPSH of 1.82 m (6 ft), so the margin between design NPSH reduction and actual NPSH reduction is available. The addition of water treatment chemicals to the essential service water system increases the water vapor pressure, resulting in available NPSH reduction of as much as 1.82 m (5.98 ft), according to American National Standards Institute/ Hydraulic Institute (ANSI/HI) 9.6.1-1998, "American National Standards for Centrifugal and Vertical Pumps for NPSH Margin," Section 9.6.1.5.4, Part c. In a November 04, 2011, response to RAI 345, Question 09.02.01-34 (follow-up to RAI 119, Question 09.02.01-08), the applicant stated the NPSH for a typical ESWS pump is 9.11 m (29.9 ft) (absolute water column). The actual value depends upon selection of a particular pump from a vendor.

The staff has determined that the estimated NPSH for a typical ESWS pump (yet to be determined since a particular vendor has not been selected) is 9.11 m (29.9 ft), and the available NPSH for the assumed worst case for elevation 305 m (1,000.66 ft), was determined to be 9.51 m (31.20 ft of water), thus there is a margin between and available NPSH of approximately 0.40 m (1.31 ft) which is acceptable at 72 hrs post DBA at the DBA water temperature of 35 °C (95 °F). The NPSH available calculation conservatively included a reduction of 1.82 m (6 ft) for water treatment chemicals. In addition, FSAR Tier 1, Table 2.7.11-3, ITAAC 7.2 will verify that the ESWS pump NPSHA is greater than the NPSH credited with consideration for minimum tower basin level and corrected for temperature and atmospheric conditions. ESWS water level requirements are further discussed in Section 9.2.1.4.2, "Technical Specifications," of this report.

Accordingly, the staff finds that the ESWS pump net positive suction head has been adequately addressed in the FSAR with respect to GDC 44.

- Water Hammer

Water hammer was previously discussed above under GDC 4 in this report.

- Operating Experience

GL 89-13, "Service Water System Problems Affecting Safety-Related Equipment," was issued to address the observed degradation over time of service water systems. The GL called for implementation of programmatic controls, surveillance, and routine inspection and maintenance to assure that the performance capability and integrity of service water systems are adequately maintained over time.

Means are used to address the staff's concerns stated in GL 89-13 regarding the design of the ESWS for the U.S. EPR. A combination of design means, such as chemical treatment to reduce biological challenges; provisions to permit regular, periodic inspections, preventative maintenance, testing and performance trending; the use of best design practices for piping material selection and layout to minimize erosion and corrosion; and administrative controls in the form of operating, maintenance, and emergency procedures, provide a level of assurance that the ESWS is able to perform its safety function when called upon.

Design provisions of the ESWS, related to GL 89-13, are described in FSAR Tier 2, Sections 9.2.1.6, "Inspection and Testing Requirements," and 9.2.5.6, "Inspection and Testing Requirements," which states:

- Identify and reduce the incidence of flow blockage problems caused from biofouling.
- Verify the heat transfer capability of safety-related heat exchangers connected to or cooled by the ESWS.
- Conduct routine inspection and maintenance activities of ESWS piping and components to provide assurance that corrosion, erosion, protective coating failure, silting, and biofouling cannot degrade the performance of safety-related systems supplied by ESW.
- The inspections will include periodic inspections of the UHS cooling tower basins to identify macroscopic biological fouling organisms, such as blue mussels, American oysters and Asiatic clams, sediment and corrosion, biocide treatment of the system, flushing and flow testing of redundant and infrequently used cooling loops and equipment, and periodic sampling to identify the presence of Asiatic clams. Chemical treatment with the appropriate biocide(s) will be performed in response to positive biological fouling test results, and the frequency of treatment will be adjusted as appropriate. Biocide treatment will be in accordance with applicable Federal, State and local environmental regulation.

The staff finds that GL 89-13 was adequately addressed with respect to GDC 44, since water chemistry measures will minimize corrosion, prevent scaling formation, and limit biological and sedimentary fouling that could inhibit flow.

GL 96-06 was issued by the NRC to address the potential for (1) water hammer and/or two phase flow in cooling water systems penetrating the containment, and (2) thermally induced over-pressurization of isolated water-filled piping sections in containment that could jeopardize the function of accident mitigation systems and could also lead to a loss of containment integrity.

The staff concluded that GL 96-06 does not apply to the ESWS, because the system is not routed through containment, and it does not provide a direct cooling interface with the containment fan coolers.

During a recent review of industry operating experience, the staff found that some licensees were experiencing significant wall thinning of pipe downstream of butterfly valves that were being used to throttle service water flow.

FSAR Tier 2, Section 9.2.1.3.5 describes that butterfly valves are used in the ESWS for isolation (open or closed) service and not for throttling. In those applications where a butterfly valve is used in the ESWS and is subject to substantial throttling service for extended periods of time, design provisions are considered to prevent consequential pipe wall thinning immediately downstream of these valves. Such design provisions include the use of erosion resistant materials, the use of thick wall pipe, and installing straight pipe lengths immediately downstream of the affected valves. In addition, the ASME Code Class ESWS piping is inspected and maintained in accordance with ASME B&PV Code, Section XI. The ASME Section XI Program for Class 2 and 3 components is described in FSAR Tier 2, Section 6.6, "Inservice Inspection of Class 2 and 3 Components." Implementation of the ASME Section XI Program is the responsibility of the combined license (COL) applicant. This activity will be implemented by an existing COL information item, which is included in FSAR Tier 2, Table 1.8-2, "U.S. EPR Combined License Information Items," as Combined License Information Item No. 6.6-1.

In a March 27, 2009, response to RAI 119, Question 09.02.01-11, the applicant described that ESWS users have a fixed flow resistance with flow rates that are adjusted during plant start up for the most limiting system configuration. Adjustments are made using globe valves, or a combination of a fixed orifice plate upstream and a butterfly valve. In the latter configuration, the fixed orifice plate provides the majority of the flow resistance, and the butterfly valve is used for minor adjustment. Use of a fixed orifice plate upstream of a butterfly valve to establish a fixed flow resistance greatly reduces the probability of pipe erosion, which can occur immediately downstream of butterfly valves when valve throttling is severe and for protracted periods. Butterfly valves are subjected to continuous but limited throttling service in the outlet flow path of the CCWS HX and the EDG Coolers. The emergency blow down path motor-operated butterfly valve was described as subject to short term (abnormal condition) throttling service. No special considerations are warranted for this service due to limited use. Several motor-operated butterfly valves will be subject to substantial throttling service for extended periods of time during cold weather. Such valves include cooling tower return isolation and bypass valves 30PED10/20/30/40 AA010 and AA011. These valves will be positioned by the operator from the MCR, as necessary, to maintain the desired ESWS cold water temperature during low load, low ambient temperature conditions.

The staff finds that the ESWS potential piping wall thinning is adequately addressed given design provisions such as the use of erosion resistant materials, the use of thick wall pipe, and the installation of straight pipe lengths immediately downstream of the affected valves. In addition, the ASME Section XI program would inspect for pipe wall thinning conditions.

Accordingly, the staff finds that relevant operating experience for ESWS has been adequately addressed in the FSAR with respect to GDC 44. Related to heat transfer and flow capabilities and single failure ESWS descriptive information, ESWS pump NPSH, and operating experience was evaluated and found acceptable.

- GDC 45, "Inspection of Cooling Water System"

The ESWS must be designed so that periodic inspections of important components, such as heat exchangers and piping, can be performed to assure that the integrity and capability of the system will be maintained over time in accordance with GDC 45 requirements. By periodic monitoring to detect signs of system degradation or incipient failure, GDC 45 provides assurance that the SWS will function reliably to provide decay heat removal and essential cooling for safety related equipment.

FSAR Tier 2, Section 9.2.1.1 describes that the ESWS is designed to permit inspection of important components necessary to maintain the integrity and capability of the system (GDC 45). FSAR Tier 2, Section 9.2.1.6 describes that the ESWS provides accessibility for the performance of periodic inspection and testing, including inservice inspection. FSAR Tier 2, Section 6.6 provides details concerning the extent and nature of inservice inspection of ASME Code Class 2 and 3 piping and components. FSAR Tier 2, Table 1.8-2, contains several items calling for COL applicants to implement inservice inspection, examination, and testing programs meeting the requirements of the ASME Code. Specifically, buried piping and components are not within the scope of the FSAR as noted in FSAR Tier 2, Table 1.8-1, "Summary of U.S. EPR Plant Interfaces with Remainder of Plant," Item No. 3-5; however, a COL information item is described in FSAR Tier 2, Section 3.8.4.7, "Testing and Inservice Inspection Requirements," that calls for the COL applicant to address examination of buried safety-related piping in accordance with ASME Section XI, IWA-5244.

The staff finds that the FSAR addresses that the US EPR ESWS design provided ready access to accommodate comprehensive inspections using currently available equipment and techniques.

Accordingly, the staff finds that periodic inspections of piping and components including buried piping for the ESWS have been adequately addressed in the FSAR in accordance with GDC 45.

- GDC 46, "Testing of Cooling Water System"

The ESWS must be designed so that periodic pressure and functional testing of components can be performed to assure the structural and leak tight integrity of system components, the operability and performance of active components, and the operability of the system as a whole and performance of the full operational sequences that are necessary for accomplishing the ESWS safety functions in accordance with GDC 46 requirements. The staff finds the design acceptable if the FSAR describes pressure and functional test program requirements that can be implemented for the given ESWS design description and which are considered adequate for this purpose.

FSAR Tier 2, Section 9.2.1.1 describes that the ESWS is designed to permit appropriate periodic pressure and functional testing necessary to maintain structural and leak-tight integrity of its components, the operability and performance of the active components of the system, and the operability of the system as a whole. The ESWS is also designed to make sure the performance of the full operational sequence necessary to bring the system into operation for reactor shutdown is satisfactory. For loss-of-coolant accident (LOCA) conditions, operation of applicable portions of the protection system (PS), and the transfer between normal and emergency power sources are also provided (GDC 46).

FSAR Tier 2, Chapter 16.0, Surveillance Requirement 3.7.8 describes the surveillance requirements that verify continued operability of the ESWS. ESWS is a safety-related system (ASME Code Class 3) and is subject to inservice inspection and testing in accordance with ASME Section XI and the ASME OM Code, respectively. FSAR Tier 2, Section 9.2.1.6 states that the installation and design of the ESWS provides accessibility for the performance of periodic inservice inspection and testing. Periodic inspection and testing of all safety-related equipment verifies its structural and leak tight integrity and its availability and ability to fulfill its functions. Inservice inspection and testing requirements are in accordance with ASME B&PV Code, Section XI and the ASME OM Code. FSAR Tier 2, Section 3.9, "Mechanical Systems and Components," and FSAR Tier 2, Section 6.6 outline the inservice testing and inspection requirements.

The staff finds the FSAR addresses that the ESWS is adequately designed for periodic pressure and functional testing to assure structural and leaktight integrity, operability and performance, and operability under worst case conditions. Since the ESWS is designed, built, and tested to the requirements of ASME Section III and will be periodically tested to the requirements of ASME Section XI and TS, the structural and leaktight integrity of the ESWS is assured by compliance with the ASME Codes. The operability and performance of the ESWS is assured by meeting TS surveillances.

In summary, the staff finds that periodic pressure and functional testing for the ESWS have been adequately addressed in the FSAR in accordance with GDC 46.

- Minimization of Contamination; 10 CFR 20.1406, "Minimization of contamination."

10 CFR 52.47(a)(6), "Contents of applications; technical information," and 10 CFR 20.1406, require that applicants for standard plant design certifications describe how facility design and procedures for operation will minimize contamination of the facility and the environment. The staff's review criteria (SRP Section 9.2.1, Paragraph III.3.D) specify that provisions should be provided to detect and control leakage of radioactive contamination into and out of the ESWS. The staff considers the design acceptable if the ESWS P&IDs show that radiation monitors are located on the ESWS discharge and at components that are susceptible to leakage, and if the components that are susceptible to leakage can be isolated.

The ESWS is not normally expected to be radioactive. Potential radioactive material in the ESWS is an indication of leakage within the CCWS heat exchanger equipment. FSAR Tier 2, Section 9.2.1.2, "System Description," FSAR Section 11.5.4.9 describes the operational characteristics of the ESWS radiation monitoring system and sampling provisions, and Section 12.3.6.5.7, "Essential Service Water System," describes the approach used in designing systems to minimize the cross-contamination of non-radioactive systems and prevent unmonitored and uncontrolled releases of radioactivity in the environment. Each of the four ESWS divisions plus the dedicated ESWS has a radiation monitor downstream of the CCWS heat exchangers. This location of the monitors represents the closest location to the potential point of contamination. Detection of radiation exceeding a predetermined setpoint will provide an alarm in the MCR for operator actions. Two valves that are installed in series upstream and downstream of the ESWS side of the CCWS heat exchangers are capable of isolating the potentially contaminated ESWS loops. To prevent the spreading of contamination consistent with 10 CFR 20.1406, isolation of the ESWS will be performed in the Safeguard Building before the potentially contaminated fluid exits the building.

The staff concludes that the radiation monitors, locations, and related ESWS isolation valves are acceptable, since the guidance in SRP Section 9.2.1, Paragraph III.3.D and 10 CFR 20.1406 for the ESWS has been adequately addressed.

9.2.1.4.2 Technical Specifications

TS 3.7.8, "Essential Service Water (ESW) System," provides limiting conditions for operation (LCOs) and surveillance requirements for the ESWS. TS requirements are evaluated in Chapter 16 of this report, in part, to confirm consistency with the provisions of the Standard TS (STS) as reflected in NUREG-1431, "Standard Technical Specifications Westinghouse Plants," Revision 3. The staff reviewed ESWS design and operational considerations in this section to confirm that they are adequately reflected in the proposed TS requirements and to assure that the TS Bases are reflective of the TS requirements that are proposed. The staff's evaluation of the TS 3.7.19, "Ultimate Heat Sink (UHS)," requirements that pertain to the UHS is provided in Section 9.2.5 of this report.

LCO 3.7.8, Action A, allows one ESWS division to be inoperable for up to 120 days.

As described in the applicant's March 27, 2009, response to RAI 119, Question 09.02.01-16, the 120-day allowed outage time (AOT) duration is not a risk-informed value, and the U.S. EPR safety analysis assumptions are satisfied with two operable ESWS divisions. The long AOT is justifiable for one division from a deterministic standpoint, and the proposed AOT was not intended to be a temporary relaxation of the requirement to postulate a single failure concurrent with a design-basis event. Finally, the 120-day AOT does not constitute a deviation from the

Standard Technical Specifications; rather, it is an additional conservative restriction that maximizes availability of the ESWS.

The staff's review of this LCO included the relevant criteria in 10 CFR 50.36, "Technical specifications"; NUREG-1431, Revision 3; STS 3.7.8; and FSAR Tier 2, Chapter 16. The staff concludes that the criteria contained in 10 CFR 50.36 referenced by the applicant identify categories of structures, systems, components, and design features for which LCOs are required. The staff noted that the operability of the fourth ESWS division was not assumed by the accident analysis and, therefore, not essential to establish the design-basis for the ESWS.

The basis for the applicant's position is that a minimum of two ESWS divisions is credited for accident mitigation; therefore, three operable divisions are sufficient to address a design-basis event in conjunction with a single failure that causes the loss of one of the divisions. Although this might at first appear to differ from STS 3.7.8, the staff determined that STS Bases 3.7.8 is based on the assumption of a reference plant design with two 100 percent capacity service water divisions. The staff concludes that this is similar to the U.S. EPR with three operable ESWS divisions in that the reference plant will also retain 100 percent capability in the event of an accident with a single failure that causes loss of one division. Consistent with this position, the staff concludes the applicant's explanation that the 120-day AOT is intended to be an additional conservative restriction to maximize the availability of the ESWS is acceptable. Further evaluation of the ESWS AOT is found in Section 16.4.11 of this report.

Surveillance Requirement 3.7.19.1 and SR 3.7.19.2 require measurement of cooling tower basin water level to ensure it is equal to or greater than 7.24 m (23.75 ft) [elevation 2.36 m (7.74 ft)] during normal operation and measurement of UHS cooling tower basin temperature to ensure it is equal to or less than 32.2 °C (90 °F) during normal operation, respectively. FSAR Tier 2, Figure 9.2.5-3 shows the cross-section of the UHS basin and describes the associated margins, alarms, water volumes (including operating bands, and 72-hour water volumes); and FSAR Tier 2, Section 9.2.5, "Ultimate Heat Sink," explains the basis for this information. For the minimum water level specified in SR 3.7.19.1 after 72 hrs post-accident, the basin water level will be no lower than elevation -1.70 m (-5.58 ft) with 0.15 m (5.91 in.) margin to the minimum pump submergence elevation -1.85 m (-6.07 ft). In a November 04, 2010, response to RAI 345, Question 09.02.01-41, the applicant stated that the ESWS pumps will be able to perform their intended safety-related function and remain operable at this water level elevation. Additionally, a 0.25 m (9.84 in.) basin level margin is provided above the minimum 72-hour water losses volume at elevation 2.11 m (6.92 ft).

The staff evaluation of the applicant's ESWS pump house water level analysis, which addresses ESWS pump water levels for NPSH, vortex suppression, and instrumentation uncertainty, is in Section 9.2.1.4.1.D (4) of this report.

The Bases for TS 3.7.8 (Page B 3.7.8-1) states that for an accident: "The pumps are automatically started upon receipt of a safety injection signal, and all essential valves are aligned to their post accident positions." As described in FSAR Tier 2, Section 9.2.1.7, the following actions occur during an automatic system alignment based on accident signals or system pump starts and stops:

The following valves receive a signal to automatically align to their post accident position (closed) upon receipt of a safety injection signal as per FSAR Tier 2, Section 9.2.1.7.1.4:

- ESWS normal blowdown isolation valves 30PEB10/20/30/40 AA016

- Cooling tower emergency blowdown system isolation valves 30PEB10/20/30/40 AA003
- Debris filter blowdown isolation valves 30PEB10/20/30/40 AA015
- ESWS debris filter emergency blowdown isolation valve, 30PEB10/20/30/40 AA004
- ESWS cooling tower bypass isolation valves 30PED10/20/30/40 AA011
- ESWS normal makeup water isolation valves 30PED10/20/30/40 AA019
- ESWS pump recirculation isolation valves 30PEB10/20/30/40 AA002

The following valves receive a signal to automatically align to their post accident position (open) upon receipt of a safety injection signal:

- ESWS pump discharge isolation valves 30PEB10/20/30/40 AA005
- ESWS cooling tower return isolation valves 30PED10/20/30/40 AA010
- ESWS emergency makeup water isolation valves 30PED10/20/30/40 AA021

The following valves are automatically re-aligned in response to a pump start/stop:

- ESWS pump discharge isolation valves 30PEB10/20/30/40 AA005 (open/closed)

The staff confirmed that those ESWS valves that are credited for a change in position (TS B. 3.7.8) in response to a SI signal and ESWS pump starts or pump stop have been adequately described. These valves have to change position in order for the ESWS to perform its intended function for cooling under various accidents.

The staff finds that the TS for the ESWS have been adequately addressed and comply with 10 CFR 50.36.

9.2.1.4.3 Inspections, Tests, Analysis, and Acceptance Criteria

FSAR Tier 1, Section 2.7.11, “Essential Service Water System,” provides EPR design certification information and ITAAC for the ESWS and UHS. FSAR Tier 1 information for balance-of-plant SSCs is evaluated in Section 14.3.7, “Plant System ITAAC,” of this report, and evaluation of FSAR Tier 1 information in this section is an extension of the evaluation provided in Section 14.3.7 of this report. This evaluation pertains to plant systems aspects of the proposed FSAR Tier 1 information for ESWS. Plant-systems aspects of proposed FSAR Tier 1 information for the UHS are evaluated in Section 9.2.5 of this report.

The staff reviewed the descriptive information, safety-related functions, arrangement, design features, environmental qualification, equipment and system performance I&C features, and interface information provided in FSAR Tier 1, Section 2.7.11 to confirm completeness and consistency with the plant design basis as described in FSAR Tier 2, Section 9.2.1. The staff also reviewed FSAR Tier 1, Table 2.7.11-1, Table 2.7.11-2, “Essential Service Water System Equipment I&C and Electrical Design,” Table 2.7.11-3, and Figure 2.7.11. The ESWS and UHS are combined into FSAR Tier 1, Section 2.7.11.

The staff concludes that all the necessary equipment has been adequately identified in the applicable tables. In addition, all of the ITAAC for ESWS have been properly identified and include (but are not limited to) ASME code data reports, system hydrostatic testing, ESWS check valve testing, ESWS water delivery to key components, verification of ESWS pump NPSH, ESWS heat load capability, and ESWS switch over testing. These attributes of the ITAAC serve to verify that the ESWS has been constructed and installed as designed. Therefore, the staff considers the ESWS ITAACs are adequately described for the U.S. EPR design certification.

As described above, the staff reviewed the information provided in FSAR Tier 1, Table 2.7.11-3 and finds that the proposed ITAAC are adequate. The staff concludes that if the ITAAC for ESWS are performed and the acceptance criteria met, there is reasonable assurance that the design is built and will operate in accordance with the design certification, the provision of the Atomic Energy Act of 1954, and NRC regulations which include 10 CFR 52.47(b)(1).

9.2.1.4.4 Initial Test Program

FSAR Tier 2, Section 14.2.12.5.7, "Essential Service Water System (Test #048)," describes the initial test program for the ESWS. The initial test program for the U.S. EPR is evaluated in Section 14.2 of this report, and evaluation of the ESWS initial test program in this section is an extension of the evaluation provided in Section 14.2 of this report.

FSAR Tier 2, Section 14.2.12.5.7, Test No. 048 includes (but is not limited to) verification of ESWS pump rated flows and developed head, adequate ESWS pump, NPSH, ESWS switchover function, and of proper operation of water hammer mitigating design features, for example air release valves. In addition, the ESWS pumps are started and testing verifies that there is no evidence of a water hammer.

Accordingly, the staff finds that FSAR Tier 2, Section 14.2.12.5.7, (Test No. 48) adequately describes the required necessary preoperational testing based on the design description in FSAR Tier 2, Section 9.2.1.

9.2.1.5 *Combined License Information Items*

Table 9.2.1-1 provides a list of essential service water system related COL information item numbers and descriptions from FSAR Tier 2, Table 1.8-2:

Table 9.2.1-1 U.S. EPR Combined License Information Items

Item No.	Description	FSAR Tier 2 Section
9.2-4	A COL applicant that references the U.S. EPR design certification will provide a description of materials that will be used for the essential service water system (ESWS) at their site location, including the basis for determining that the materials being used are appropriate for the site location and for the fluid properties that apply.	9.2.1.3.5

The staff finds the above listing to be complete. Also, the list adequately describes actions necessary for the COL applicant. No additional COL information items need to be included in FSAR Tier 2, Table 1.8-2 for essential service water system consideration.

9.2.1.6 *Conclusions*

Except for the confirmatory item associated with RAI 465, Question 09.02.01-51 (the incorporation of Interim FSAR Revision 3 in the next FSAR revision), and based on the review summarized above, the staff concludes that the ESWS design complies with the guidance in NUREG-0800, Section 9.2.1, and that the information provided adequately demonstrates that the requirements of 10 CFR Part 50, Appendix A, "General Design Criteria for Nuclear Power Plants," GDC 2, GDC 4, GDC 5, GDC 44, GDC 45, GDC 46, and 10 CFR 20.1406 are met. In addition, the staff finds that the proposed ITAAC requirements are sufficient to demonstrate that the design, if build and the acceptance criteria are met, is constructed and will be operated in accordance, with the certified design and, therefore, the requirements of 10 CFR 52.47(b)(1) are also met.

9.2.2 Component Cooling Water System

9.2.2.1 *Introduction*

The CCWS is a closed loop cooling water system that removes heat from safety-related and non-safety-related components during normal operating, accident, and shutdown conditions. It provides an intermediate barrier between the radioactive or potentially radioactive heat sources and the normally non-radioactive essential service water system. The heat from these components to the CCWS is rejected to the ESWS via the CCWS heat exchangers (HXs). This arrangement minimizes the possibility of leakage of radioactive materials into the environment.

The CCWS consists of four independent safety-related divisions with the principal equipment of each division located in its respective Seismic Category I Safeguard Building. This equipment includes one CCWS pump, one heat exchanger, a surge tank, a sampling line with a continuous radiation monitor, valves (including valves for isolating the safety-related from the non-safety-related portions of the system and valves capable of automatically switching the CCWS division supplying the common header), piping, and instrumentation and controls. Also, the CCWS has common supply headers for providing cooling water to both safety-related and non-safety-related loads. Common headers '1a' and '1b' are supplied by Divisions 1 and 2, and common headers '2a' and '2b' are supplied by Divisions 3 and 4. The following are the safety-related systems, components, and functions served by the CCWS:

- Low Head Safety Injection (LHSI)/residual heat removal (RHR) heat exchangers
- CCWS pump motor coolers
- Safety chilled water system (Divisions 2 and 3 only; Divisions 1 and 4 are air cooled)
- Medium head safety injection pump motor coolers
- LHSI pump motor and seal coolers (Divisions 2 and 3 only; Divisions 1 and 4 are cooled by the safety chilled water system)
- Spent fuel pool (SFP) cooling water heat exchangers

- Reactor coolant pump (RCP) seal thermal barrier cooling

The following are the major non-safety-related systems and components located inside the Fuel Building, Reactor Building (RB), Radioactive Waste Processing Building (RWB), and Nuclear Auxiliary Building (NAB), served by the CCWS:

- High pressure (HP) chemical and volume control system (CVCS) cooler
- Reactor coolant pump upper and lower bearing oil and motor air coolers
- Heating, ventilation, and air conditioning (HVAC) coolers in the RB
- Reactor coolant drain tank (RCDT) cooler

In addition, one non-safety-related dedicated CCWS division is provided for cooling the severe accident heat removal system (SAHRS) heat exchanger to address severe accident considerations.

Each safety-related CCWS division is powered by an ASME Code Class 1E electric bus with emergency power from its associated EDG. The dedicated CCWS division which cools the SAHRS heat exchanger is also powered by the ASME Code Class 1E, Division 4 electric bus and receives emergency power from the associated EDG or station blackout diesel generators.

9.2.2.2 *Summary of Application*

FSAR Tier 1: Specific design requirements that pertain to the component cooling water system are described in FSAR Tier 1, Interim Revision 3, Section 2.7.1 “Component Cooling Water System.” The functional arrangement of the CCWS is shown in FSAR Tier 1, Figure 2.7.1-1, “Component Cooling Water System Functional Arrangement,” Sheets 1 to 11. Mechanical design information is provided in FSAR Tier 1, Table 2.7.1-1, “Component Cooling Water System Equipment Mechanical Design,” which provides physical locations, function, ASME Section III applicability, and seismic category. Instrumentation and controls, electrical design information including power supplies, and display locations are identified in FSAR Tier 1, Table 2.7.1-2, “Component Cooling Water System Equipment I&C and Electrical Design.” FSAR Tier 1, Table 2.7.1-3, “Component Cooling Water System ITAAC,” gives the CCWS ITAAC.

FSAR Tier 2: The CCWS and it design basis are described in detail in FSAR Tier 2, Interim Revision 3, Section 9.2.2, “Component Cooling Water System,” and in FSAR Tier 2, Figures 9.2.2-1, “Component Cooling Water System s 1 through 4,” 9.2.2-2, “Component Cooling Water System Common Loop 1,” 9.2.2-3, “Component Cooling Water System Common Loop 2,” and 9.2.2-4, “Component Cooling Water System Dedicated CCWS Trains.”

ITAAC: As discussed in the above summary of FSAR Tier 1 information, ITAAC for the CCWS are included in FSAR Tier 1, Table 2.7.1-3. Discussion of the ITAAC for CCWS is provided below in Section 9.2.2.4, “Technical Evaluation.”

Initial Test Program: Pre-operational testing for the CCWS is described in FSAR Tier 2, Section 14.2.12.5.5, “Component Cooling Water System (Test #046).” Discussion of the pre-operational test program for CCWS is provided in Section 9.2.2.4 of this report.

Technical Specifications: Technical Specifications for the CCWS are provided in FSAR Tier 2, Chapter 16, “Technical Specifications,” TS 3.7.7, “Component Cooling Water (CCW) System.” A discussion of the TS for the CCWS is provided in Section 9.2.2.4 of this report.

9.2.2.3 *Regulatory Basis*

The relevant requirements of NRC regulations for this area of review, and the associated acceptance criteria, are given mainly in NUREG-0800, Section 9.2.2, “Reactor Auxiliary Cooling Water System,” Revision 4, and are summarized below. Review interfaces with other SRP sections also can be found in NUREG-0800, Section 9.2.2.

1. GDC 2, “Design Basis for Protection Against Natural Phenomena,” as it relates to the capabilities of structures housing the system and the system itself having the capability to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, floods, tsunami, and seiches without loss of safety-related functions.

2. GDC 4, “Environmental and Dynamic Effects Design Bases,” as it relates to effects of missiles inside and outside containment, effects of pipe whip, jets, environmental conditions from high- and moderate-energy line-breaks, and dynamic effects of flow instabilities and attendant loads (e.g., water hammer) during normal plant operation, as well as upset or accident conditions.

3. GDC 5, “Sharing of Structures, Systems, and Components,” insofar as it requires that SSCs important to safety not be shared among nuclear power units unless it can be shown that sharing will not significantly impair their ability to perform their safety functions.

4. GDC 44, “Cooling Water,” as it relates to the capability to transfer of heat from systems, structures, systems, and components important to safety to an ultimate heat sink during both normal and accident conditions, with suitable redundancy, assuming a single active component failure coincident with either the loss of offsite power or loss of onsite power.

5. GDC 45, “Inspection of Cooling Water System,” as it relates to design provisions for inservice inspection of safety-related components and equipment.

6. GDC 46, “Testing of Cooling Water System,” as it relates to design provisions for pressure and operational functional testing of cooling water systems and components in regard to

   - Structural integrity and system leak-tightness of its components
   - Operability and adequate performance of active system components
   - Capability of the integrated system to perform credited functions during normal, shutdown, and accident conditions

7. 10 CFR 52.47, “Contents of applications; technical information,” Item (b)(1), which requires that a design certification application contain the proposed ITAAC that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a facility that incorporates

the design certification has been constructed and will be operated in accordance with the design certification, the provisions of the Atomic Energy Act, and NRC regulations.

8. 10 CFR 20.1406, “Minimization of Contamination,” as it relates to the standard plant design certifications and how the design and procedures for operation will minimize contamination of the facility and the environment facilitate eventual decommissioning and minimize to the extent practicable, the generation of radioactive waste.

Acceptance criteria adequate to meet the above requirements include:

- RG 1.29, “Seismic Design Classification,” March 2007, (Seismic Design Criteria), Regulatory Position C.1 for safety-related and Regulatory Position C.2 for non-safety-related portions of the CCWS.

9.2.2.4 *Technical Evaluation*

The staff evaluation of the CCWS is based upon the information provided by the applicant in a February 18, 2011, response to RAI 465, Question 9.2.1-51, that transmitted FSAR Tier 2, Section 9.2.2, Interim Revision 3, markups as in other FSAR sections as referred to below.

The staff requested that the applicant respond to questions in 77 RAIs that were based on the information in FSAR Tier 2, Revisions 0, 1, and 2 that described the design, operation, and testing of the CCWS. The applicant answered these questions in numerous responses that included FSAR markups which the staff has reviewed and finds acceptable because, in RAI 465 Question 09.02.01-51, the staff requested that the applicant compile and submit an FSAR markup that incorporated all the FSAR markups that were submitted separately as part of the responses to the 77 RAIs. In a February 19, 2011, response to RAI 465, Question 09.02.01-51, the applicant provided an Interim FSAR Revision 3 markup for the applicable sections.
The staff reviewed the FSAR Interim Revision 3 mark-up and confirmed that all of the CCWS RAI response markups had been successfully incorporated into it. In this report, the staff is not describing each staff RAI and the information the applicant provided in response to each RAI; rather, the staff’s technical evaluation below is based on the staff’s review of the interim FSAR Revision 3 markup for the applicable sections, which includes all the information submitted in response to the original 77 staff RAIs. In some cases, the staff may discuss the applicant’s RAI responses where clarifying information which is not described in the FSAR to ensure that information is ultimately included in the FSAR, RAI 465, Question 09.02.01-51 is being tracked as a confirmatory item**.**

GDC 2

The staff reviewed the CCWS to confirm that the applicant has complied with the requirements of GDC 2 as it relates to its design for protection against the effects of natural phenomena such as earthquakes, tornados, hurricanes, and floods. Compliance with the requirements of GDC 2 is based on meeting the guidance of RG 1.29, Regulatory Position C.1 for the safety-related portions of the system, and RG 1.29, Regulatory Position C.2, for non-safety-related portions of the system.

FSAR Tier 2, Section 3.2, “Classification of Structures, Systems and Components,” identifies SSCs based on safety importance and other considerations. FSAR Tier 2, Table 3.2.2-1, “Classification Summary,” documents the component safety classification, seismic classification, quality group classification, commercial codes, and locations for the SSCs. The staff finds that the safety classification, quality group, seismic category, and location for CCWS components are properly designated.

The staff reviewed the piping and instrumentation diagrams (P&IDs) for the CCWS and determined that essential parts of the system (including boundary isolation valves) are properly designated as safety-related, Seismic Category I, Quality Group C and that non-essential parts are properly designated as non-safety-related. The staff confirmed that this information is correctly reflected in FSAR Tier 2, Table 3.2.2-1, "Classification Summary," Sheets 103 through 108, and that 10 CFR Part 50, Appendix B requirements are appropriately specified for the safety-related parts of the system.

All safety-related portions of the CCWS are located inside Seismic Category I, tornado-, missile-, and flood-protected buildings. Accordingly, they are protected from these severe natural phenomena in accordance with GDC 2. Further, valves for isolating the safety-related from the non-safety-related portions of the system are fast acting hydraulic operated isolation valves designed to fail "closed" on loss of power to the hydraulic pilot circuit. Accordingly, the system is also designed to ensure that failure of any non-safety-related portions of the system will not compromise any safety function of the CCWS.

The staff's evaluations of protections provided for SSCs important to safety are included in the following sections of this report:

- Section 3.4.1 of this report documents the staff's evaluation of flood protection provided for SSCs important to safety.
- Section 3.5.1.1 of this report documents the staff's evaluation of protection provided for SSCs important to safety from internally generated missiles outside containment.
- Section 3.5.1.2 of this report documents the staff's evaluation of protection provided for SSCs important to safety from internally generated missiles inside containment.
- Section 3.5.1.4 of this report documents the staff's evaluation of protection provided for SSCs important to safety from missiles generated by natural phenomena.
- Section 3.5.2 of this report documents the staff's evaluation of protection provided for SSCs important to safety from externally generated missiles.
- Section 3.7.3 of this report documents the staff's evaluation of protection provided to prevent non-seismic lines and equipment from having adverse interactions with SSCs important to safety. FSAR Tier 2, Section 3.7.3.8, "Interaction of Other Systems with Seismic Category I Systems," identifies acceptable methods to address the potential for interaction between seismically qualified and non-seismically qualified portions of the CCWS that are routed through the same areas. As an example, in FSAR Tier 2, Section 9.2.2.2, the applicant states that non-seismic portions of the CCWS are isolated from safety-related SSCs by either physical separation or by the use of physical barriers. The staff finds this explanation acceptable, since physical separation or physical barriers are utilized in the design. Section 3.7 of this report further describes FSAR Tier 1 ITAAC require a licensee referencing the design to verify the as-built condition (separation or barriers) to ensure that non-safety-related SSCs will not adversely affect the function of safety-related SSCs during and after a safe-shutdown earthquake.

Therefore, the staff finds that the design of the CCWS meets GDC 2, with respect to being capable of withstanding the effects of natural phenomena without loss of capability to perform its safety functions, since RG 1.29, Regulatory Position C.1 for safety-related portions of the CCWS, and RG 1.29, Regulatory Position C.2 for the non-safety-related portions of the CCWS have been adequately addressed.

GDC 4

The staff reviewed the CCWS to determine if the design complies with the relevant requirements of GDC 4. Section 3.6.1 of this report addresses the staff's evaluation of the design of structures, shields, and barriers necessary for SSCs to be protected against dynamic effects of high-energy line breaks. Based on the staff's evaluation discussed in Section 3.6.1 of this report, the staff finds that the CCWS is protected against the effects of, and is compatible with, the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents.

SRP 9.2.2 guidance states that the design provisions presented in NRC GL 96-06, "Assurance of Equipment Operability and Containment Integrity during Design - Bases Accident Conditions and Water Hammer," are appropriately addressed provided the following considerations are included:

1. Cooling water systems serving the containment air coolers can be exposed to the hydrodynamic effects of water hammer during either a LOCA or a main steamline break (MSLB). These cooling water systems are not typically designed to withstand the effects of water hammer.

2. Cooling water systems serving the containment air coolers can experience two-phase flow conditions during a postulated LOCA or MSLB scenarios. The heat removal assumptions of a DBA scenario are typically based on single-phase flow conditions.

3. Thermally induced over-pressurization of isolated water-filled piping sections in containment could jeopardize the function of accident mitigation systems and could also lead to a loss of containment integrity.

The staff finds that following a LOCA, the CCWS is isolated from the containment air coolers upon receipt of a Stage I containment isolation signal. Therefore, GL 96-06 Items 1 and 2 discussed above, which specifically address the containment air coolers, do not apply to the U.S. EPR design.

There are several systems that reject heat to the CCWS that would remain in service after Stage I isolation, up to Stage II isolation, including the RCPs and CVCS. FSAR Tier 2, Section 9.2.2.2.1, "General Description," describes the maximum allowed CCWS design-basis accident inlet water temperature to the containment loads is 45 °C (113 °F). Based on this inlet temperature and data provided by the applicant in a September 10, 2010, response to RAI 397, Question 9.2.2-108, including flow and heat load information provided in FSAR Tier 2, Table 9.2.2-2, "CCWS User Requirements," the staff performed an independent calculation to investigate the possibility of flashing or two phase flow in the CCWS. The staff estimated that the highest outlet temperature is 64.6 °C (148.2 °F), which confirms that neither flashing nor two phase flow is a concern. Therefore, the staff finds that the issues described in GL 96-06 are not concerns for the U.S. EPR CCWS.

Also, in FSAR Tier 2, Section 9.2.2.2.1, the applicant states that the design of the CCWS minimizes and withstands adverse transients (i.e., water hammer) and meets functional performance requirements for all operating modes, including postulated DBAs, consistent with the guidance for water hammer prevention and mitigation described in NUREG-0927, "Evaluation of Water Hammer Experience in Nuclear Power Plants," Revision 1, March 1984. Based on the staff's review of NUREG-0927, Table 3-3, "PWR Operating and Maintenance Procedures Water Hammer Considerations," rapid valve motion, introduction of voids, and system filling/venting are areas of the staff's concern for water hammer prevention in cooling water systems that are similar to the CCWS designs. Since introduction of voids and filling/venting are controlled by operational programs, the evaluation below focuses on the effect of potential rapid valve motions on CCWS design.

FSAR Tier 2, Section 9.2.2.3.1, "Normal System Operation," describes that the quick-closing hydraulically operated switchover valves are designed to close and open within 10 sec. In addition, FSAR Tier 2, Section 9.2.2.2.1 states that the 10 sec closure time of the common header switchover valves and the fast-acting hydraulically operated isolation valves for non-safety-related CCWS users are not considered to be an instantaneous closure that would create large pressure waves in the system. Also, in FSAR Tier 2, Section 14.2.12.5.5, Test No. 046, provides for testing of the CCWS for adverse hydraulic transients including specific operational sequences in which the potential for water hammer exists. Examples of the sequences to be tested include switchover of the CCWS division supplying the common header, as well as safety injection, which automatically starts pumps and isolates the non-safety-related areas with fast acting valves. Accordingly, the staff finds that the applicant's proposal for successful completion of initial plant testing before fuel load will provide reasonable assurance that the CCWS will not be subject to adverse hydraulic transients including water hammer during normal plant operation, as well as during upset or accident conditions.

Accordingly, based on the preceding discussion, the staff concludes that the CCWS meets the guidance of GL 96-06 regarding water hammer considerations, and meets the requirements of GDC 4.

GDC 5

The U.S. EPR standard plant design is a single-unit station. Therefore, the requirements of GDC 5 are not applicable to the EPR standard plant design.

GDC 44

As described in Section 9.2.2.1 of this report, the CCWS is a closed loop cooling water system that transfers heat from various safety-related and non-safety-related SSCs during all phases of plant operation including normal, accident, and shutdown conditions to the ESWS. The CCWS consists of four independent divisions. Each division containing a CCWS pump, a heat exchanger, a surge tank, as well as associated valves, piping, and I&C and provides cooling to the associated division LHSI/RHR heat exchanger and motor coolers for the CCWS and medium head safety injection (MHSI) pumps. In addition, CCWS Divisions 2 and 3 also support the LHSI pump seal and motor coolers. Other safety-related systems that reject heat to the CCWS include Divisions 2 and 3 of the safety chilled water system (SCWS) #1 and #2 fuel pool coolers (FPCs) and the four RCP thermal barrier coolers which are reject heat to the safety-related portions of either of the two CCWS common headers.

As described in FSAR Tier 2, Section 9.2.2.3, "System Operation," the four safety-related component cooling water (CCW) divisions are separated into multiple pairs and each pair provides cooling water to safety-related; as well as non-safety-related system HXs on one of the two common headers. Safety-related Divisions 1 and 2 supply common header one, and safety-related Divisions 3 and 4 supply common header two. Also, each common header is further divided into two sub-headers (i.e., 1a/1b and 2a/2b). In effect, the adjacent pairs of safety divisions are tied together on the supply and return by cross connect pipes each of which is provided with safety-related, Seismic Category I, fast acting hydraulic operated isolation valves (two total per cross connect pipe) located at each end. The supply and return for each common header is connected to a cross connect pipe between the two hydraulic isolation valves. As such, a common header can be connected to either of the two safety divisions in each pair. Separation of adjacent safety divisions is maintained in the cross-connect lines by a safety-related interlock that prevents both valves from being opened at the same time. Division separation provides assurance that a failure will affect no more than one division. The interlock, which is described further in FSAR Tier 2, Section 7.6.1.2.3, "Interlocks Isolating Redundant CCWS Divisions," will permit one of the isolation valves associated with each cross connect pipe to open only upon receipt of a signal that the other is fully closed. These valves provide the ability to rapidly transfer the source of cooling for the common headers between safety divisions and are referred to by the applicant as "switchover valves." In FSAR Tier 2, Section 9.2.2.2.1, the applicant states that the common header switchover valves will be designed to fail "as-is" on loss of power to the hydraulic pilot circuit, while the isolation valves for the non-safety-related areas will be designed to fail "closed" on loss of power to the hydraulic pilot circuit. In summary, the staff finds the information provided above by the applicant for the safety-related hydraulic valves, as well as the switchover sequence, is sufficient with respect to GDC 44, since the switchover valves "fail" in their correct position and will continue to perform their intended function during a loss of power event.

As described below, the control signals that initiate the automatic common header switchover sequence are appropriately identified in FSAR Tier 2, Section 9.2.2.6.1, "Control Features and Interlocks." The signals include: (1) Loss of a CCWS pump in the safety division supplying the common header; (2) loss of the associated ESWS pump; and (3) low flow rate to system users. The transfer sequence automatically closes the supply and returns switchover valves on the off-going division, then opens the corresponding switchover valves on the oncoming division and starts the associated CCWS pump. The CCWS pump start will also start the corresponding ESWS pump which is described in FSAR Tier 2, Section 9.2.2.6.1.5, "Additional Control Features and Interlocks." Tier 2 FSAR Section 7.6.1.1, "System Description," describes interlock systems important to safety which includes the CCWS; therefore, Section 7.6 of this report addresses the staff's evaluation of I&C for the CCWS including the sequence for valve and header alignment.

FSAR Tier 2, Section 9.2.2.2.2, "Component Description," states that the CCWS HXs are horizontal tube and shell type heat exchangers with CCWS flow on the shell side and ESW cooling water on the tube side. In addition, FSAR Tier 2, Table 9.2.2-7, "CCWS Heat Load Summary," provides a summary of CCWS heat loads for normal and accident alignments. FSAR Tier 2, Table 9.2.2-2 describes the CCWS major heat loads. Individual component heat loads included in this total were provided by the applicant in Table 9.2.2-110-4 included in the October 13, 2010 response to RAI 406, Question 09.02.02-110. The maximum heat load is expected to be 309.5 GJ/hr (293.35 MBtu/hr) under a DBA condition. The staff finds the components included in this table were reasonable and conservative, since some of the loads such as the 7.5 GJ/Hr (7.1 MBtu/hr total) RCP bearing oil and motor air coolers and a 7.3 GJ/hr (6.9 MBtu/hr) CVCS HP cooler are automatically isolated for worst case accidents involving Stage II containment isolation. The safety-related components with the highest individual heat loads in this table include the 254.3 GJ/hr (241 MBtu/hr) LHSI/RHR HX, the 30.6 GJ/hr (29 MBtu/hr) fuel pool cooler, and the 6.0 GJ/hr (5.705 MBtu/hr) safety chiller condenser.

As stated in FSAR Tier 2, Section 9.2.2.2.2, the CCWS pumps are horizontal centrifugal type pumps sized to accommodate maximum credited system flow. A summary of CCWS flow rates for several representative alignments is provided in FSAR Tier 2, Table 9.2.2-8, "CCWS Pump Flow Summary," which indicates that maximum pump flow occurs in a normal operating alignment with Division 3 or 4 connected to common header 2 plus division-specific safety injection system (SIS) loads. In an August 13, 2010, response to RAI 417, Question 09.02.02-117, the applicant stated that in this alignment the total minimum head is 0.52 MPa (172.6 ft). The design CCWS pump flow and head are provided in FSAR Tier 2, Table 9.2.2-1, "CCWS Design Parameters," as 69.3 m^3/min (18,294 gpm) and 0.60 MPa (199.7 ft) which include design margins of approximately 15 percent. The staff evaluated the individual factors and methodology (which accounted for wear, instrument uncertainty, power supply variations and system balance) and concluded that the margin used for both CCWS pump head and flow were reasonable and conservative and is consistent with industry codes and standards.

U.S. EPR accident mitigation calls for only two of the four CCWS safety-related divisions, thus providing a sufficient level of redundancy. Also, in case of a loss of offsite power, each of the four safety divisions is supported by an independent, safety-related EDG. Also, in case of loss of onsite power to one electrical division, there are three other independent safety electrical divisions to support the other remaining CCWS divisions. While the redundancy of the four division design provides an inherent tolerance to single failures, FSAR Tier 2, Table 9.2.2-6, "Component Cooling Water System – Failure Modes and Effects Analysis," provides a detailed CCWS component failure modes and effects analysis (FMEA). Section 19.0 of this report documents the staff's evaluation of the FMEA for the CCWS.

In order to provide the minimum system flow credited in the accident analysis, the CCWS is designed to assure that the minimum required NPSH for the CCWS pumps will be met for all postulated conditions, including consideration of vortex formation. In accordance with FSAR Tier 2, Table 9.2.2-1, the surge tank volume is specified as 26.9 m^3 (950 ft^3 or about 7,100 gal) which is sufficient storage capacity to accommodate at least 7 days of post seismic event system operation. Each CCWS surge tank is designed to include a minimum water volume of 2.8 m^3 (750 gal) to accommodate potential system leakage for 7 days, with no makeup source in post-seismic conditions. This reserve volume is 2.8 m^3 (750 gal) per division, which is within the capacity of the CCWS surge tank of 26.9 m^3 (950 ft^3 or about 7,100 gal), allows the system to accommodate a continuous per valve leakage of 0.004 m^3/hr (1.08 gal/hr) or 0.1 m^3/day (26 gal/day) continuous for 24 hours per day for 7 days in the event that normal non-safety-related demineralized water makeup is not available. This reserve volume of 2.8 m^3 (750 gal) for each CCWS surge tank allows each division to accommodate a total division continuous leakage rate of approximately 0.017 m^3/hr (4.46 gal/hr) or 0.41 m^3/day (107 gal/day) continuous for 24 hrs per day for 7 days in the event that normal non-safety-related demineralized water makeup is not available. In the event that normal demineralized water makeup is not available, makeup water will be supplied from the Seismic Category II fire water distribution system inside the Nuclear Island to provide for defense-in-depth.

In order to supply the minimum credited system flow, the CCWS design must assure that the minimum net positive suction head (NPSH) for the CCWS pumps will be met for all postulated conditions, including consideration of vortex formation. In accordance with Tier 2 FSAR Table 9.2.2-1 the surge tank volume is specified as 26.9 m^3 (950 ft^3 or about 7100 gallons).

The surge tank is described as an open storage tank that provides adequate water volume to accommodate maximum thermal expansion and contraction as well as anticipated system water loss due to leaks. As noted in FSAR Tier 2, Chapter 16 Technical Specification Bases B 3.7.7, the surge tank also provides a pump trip protective function to assure that sufficient net positive suction head is available to support continued pump operation.

In RAI 334, Question 09.02.02-67, Part (a), the staff requested that the applicant provide sufficient information to assure CCWS pump minimum NPSH requirements would be provided by the design of the CCWS system. In a March 12, 2010, response to RAI 334, Question 09.02.02-67, Part (a), the applicant provided an estimate of approximately 30.0 m (98.5 ft) of net positive suction head available (NPSHa) based on: (1) Maximum pump flow; (2) pipe sizes from FSAR Tier 2, Figure 9.2.2-1; and (3) the elevation difference between the Surge Tank and the associated CCWS Pump as shown on building arrangement drawings (FSAR Tier 2, Figure 3.8-85 is typical). In addition, the applicant stated that the procurement data sheets of the CCCWS pumps require 25 percent margin on pump NPSH. In support of the response to RAI 334, Question 09.02.02-67 (Part (a)), the staff examination of typical safeguards building arrangement drawings revealed a significant elevation difference (more than 30.2 m (99 ft)) between the CCW Surge Tank (21m (68 ft, 10.75 in.)) and CCW Pump room (-9.5m (-31 ft)) elevations. NPSHa represents the absolute pressure at the pump inlet, which typically includes static elevation head, plus atmospheric pressure, minus pipe line losses and vapor pressure. The staff noted that the applicant’s estimate (30m (98.5 ft of NPSH)) was reasonable since the static head was clearly the dominant parameter and the other parameters were likely to be offsetting. Based on this assessment and the pump procurement specification provision requirement for a 25 percent NPSH margin described by the applicant, the staff concluded that adequate CCWS pump NPSH margin would be assured.

As described below, the staff also noted further assurance that pump NPSH available will exceed the minimum credited NPSH is provided by FSAR Tier 1 ITAAC, Commitment Item 7.2 as well as FSAR Tier 2, Chapter 13 initial plant Test 046, Step 3.3.1. Accordingly, the staff finds the applicant’s March 12, 2010, response to RAI 334, Question 09.02.02-67 (Part (a)), in regard to NPSH acceptable.

RCP shaft seal cooling is necessary to maintain RCP seal integrity during both normal and accident conditions. In this regard, two sources of RCP seal cooling are provided, namely: (1) CVCS seal injection; and (2) CCWS thermal barrier cooling. However, in accordance with FSAR Tier 2, Section 9.3.4.1, “Design Bases,” the CVCS for the U.S. EPR is only considered for normal operation of the system and is not relied upon for accident mitigation. In addition, FSAR Tier 2, Section 9.3.4.2.3.5, “Accident Conditions,” states that CVCS lines to the RCP seal injection are isolated upon initiation of a Stage II containment isolation signal. Therefore, CCWS flow to the thermal barriers provides the only safety-related source of cooling for the RCP seals. Additionally, FSAR Tier 2, Section 9.2.2.2.1 states that RCP seal degradation is expected to occur in as little as two minutes if all cooling is lost (i.e., both CCWS and CVCS). Accordingly, CCWS thermal barrier cooling is credited to must remain functional following a single failure in order to provide continued assurance of reactor coolant pressure boundary integrity.

FSAR Tier 2, Section 9.2.2.2.1 states that CCWS cooling to all four RCP thermal barriers is provided from either common Header 1.b or 2.b. This is achieved via a cross-connection line located in containment and safety-related interlocks on the supply and return containment isolation valves that will not open the valves on the supply and the return penetration for one common header unless at least one supply containment isolation valve and one return containment isolation valve associated with the other common header are closed. The FSAR indicates that this design meets single failure criteria for the RCP thermal barrier cooling function and further explains that the thermal barrier heat load is rejected to a CCWS common header, which is capable of being connected to two operable CCWS divisions.

The staff noted that FSAR Tier 2, TS 3.7.7 requires entry into a 72 hour limiting condition for operation (LCO) if one of the two CCWS safety divisions supporting the common header providing thermal barrier cooling becomes inoperable. The inoperable division must be restored or the operators must transfer thermal barrier cooling to the other common header within 72 hours. The staff finds that these requirements provided reasonable assurance that if the safety division cooling the thermal barriers failed, then cooling would be promptly restored by automatic switchover of the common header to the redundant CCWS safety division supporting that common header. The staff concludes that this requirement is reasonable, since it would provide assurance that automatic division switchover is available to minimize the time for restoration of CCWS thermal barrier cooling in the event of a CCWS division failure. This is particularly important for the U.S. EPR design, because CVCS seal injection is not required to be operable by Technical Specifications and as previously noted, loss of all RCP seal cooling can result in seal degradation in as little as 2 minutes.

As noted above, if an inoperable CCWS safety division cannot be restored within the required time, then the operators must initiate transfer of RCP thermal barrier cooling to the other common header. The applicant refers to this remote manual sequence as semi-automatic, since it is initiated by the operators from the MCR. As originally described by the applicant (i.e., prior to FSAR Revision 3) in FSAR Tier 2, Section 7.6.1.2.3, all containment isolation valves (CIVs) associated with the off going common header were required to be full closed before the CIVs for the other operable common header were permitted to open upon operator initiation of the transfer sequence.

As stated above, the staff identified two failure concerns for this thermal barrier transfer sequence with the potential to result in the loss of all cooling to the RCP seals (both CCWS thermal barrier cooling and charging pump seal injection). The applicant addressed these concerns by revising the transfer interlock such that only one of two CIVs on the supply and one of two CIVs on the return of the off going common header are required to be closed to satisfy the permissive and enable the CIVs for the oncoming common header to open. Evaluation of the revised design is addressed by failure modes 48 (valves fail to open) and 49 (valves fail to close) of the applicant’s FMEA, which properly concludes that the design will assure that CCWS thermal barrier cooling flow is maintained in the event of LOOP after initiation of the transfer sequence with a concurrent single failure of an EDG or failure of a single CIV on the off going division in mid-position. The staff finds that the FMEA evaluation of the RCP thermal barrier cooling transfer sequence properly demonstrated the one-out-of-two logic for closing the initial supply valves plus the one-out-of-two logic for the initial return valves to close allowing the transfer to complete by opening the valves for the other oncoming header. The FMEA evaluation also confirms that CCWS flow will be restored to the thermal barriers in the event of a LOOP with a single failure of an EDG. The revised design is acceptable, since both containment isolation and CCWS division separation will still be assured.

On the basis of the above discussion, the staff finds that the CCWS complies with the requirements of GDC 44 in that the CCWS is capable of transferring its heat load to the ESWS.

GDC 45

FSAR Tier 2, Section 9.2.2.1 states that the CCWS is designed to permit appropriate periodic inspection of important components to provide assurance of the integrity and capability of the system in accordance with GDC 45. Similarly, FSAR Tier 2, Section 9.2.2.5, “Inspection and Testing Requirements,” states that the installation and design of the CCWS provides accessibility for the performance of periodic testing and inservice inspection with limited personnel exposure.

The staff finds sufficient provisions have been established to conclude that reasonable assurance of compliance with GDC 45 exists.

GDC 46

Tier 2 FSAR Section 9.2.2.1 states that CCWS is designed to permit appropriate periodic pressure and functional testing to make sure of (1) the structural and leak-tight integrity of its components, (2) the operability and the performance of the active components of the system, and (3) the operability of the system as a whole and, under conditions as close to the design as practical, the performance of the full operational sequence that brings the system into operation for reactor shutdown and for loss of coolant accidents (LOCA), including operation of applicable portions of the protection system and the transfer between normal and emergency power sources.

Normally, two divisions of CCWS operate continuously in all plant operating modes. Operation of the CCWS pumps is rotated in service on a scheduled basis to obtain even wear. These pumps can be periodically tested in accordance with plant technical specifications SR 3.7.7.3. The system is located in accessible areas to permit inservice inspection as required. Thus, the staff considers the requirements of GDC 46 satisfied.

10 CFR 20.1406 “Minimization of Contamination”

10 CFR 20.1406 requires, in part, that applicants for standard plant design certifications describe how the facility design and procedures for operation will minimize, to the extent practicable, contamination of the facility and the environment, as well as the generation of radioactive waste.

The CCWS is an intermediate closed loop cooling water system that removes heat from safety-related and non-safety-related components during normal operating, accident, and shutdown conditions. There is no direct path for release of radioactive materials from the CCWS to the environment. It has provisions for collection of samples, which are routinely taken by the operators and tested for radioactivity. In addition, CCWS radiation monitors are provided to alert the operators in case of a leak, thereby providing the opportunity for locating and isolating of the faulted equipment. Radiation detection instrumentation monitors the presence of radioactivity in the general component system and high-pressure coolers serviced by the CCWS. FSAR Tier 2 Sections 11.5.4.4 and 11.5.4.17 describe the operational characteristics of the CCWS radiation monitoring system and FSAR Tier 2 Section 12.3.6 describes the approach used in designing systems to minimize the cross-contamination of non-radioactive systems and prevent unmonitored and uncontrolled releases of radioactivity in the environment. Also, an unexpected increase in surge tank level provides another indication of a leak into the CCWS.

The staff’s evaluation of the design features of the associated radiation monitoring systems and sampling provisions are presented in Sections 11.5 and 12.3.6 of this report. Detection of radioactivity into and out of the CCWS will allow a licensee to take action to minimize contamination of the facility, prevent unmonitored and uncontrolled releases of radioactivity, and minimize the generation of radioactive waste. Therefore, the staff concludes that the CCWS design, as described in the FSAR, complies with 10 CFR 20.1406 and NRC guidance.

9.2.2.4.1 Technical Specifications

TS 3.7.7, "Component Cooling Water (CCW) System," provides LCO and Surveillance Requirements for the CCWS. TS 3.7.7 requires entry into a 72-hour LCO if one of the two CCWS safety divisions supporting the common header providing thermal barrier cooling becomes inoperable. The inoperable division must be restored or the operators must transfer thermal barrier cooling to the other common header within 72 hours.

TS SR 3.7.7.2 requires periodic (31 days) verification that leakage from each CCWS division is less than 15.1 L/hr (4.0 gal/hr). If leakage is above this limit, that CCWS division and the associated division for the common header will be declared inoperable if the associated division is not already out of service.

Chapter 16 of this report addresses the staff's evaluation of the CCWS to assure that the proposed LCOs and associated Bases adequately address and reflect system-specific design considerations as described in FSAR Tier 2, Section 9.2.2.

The staff has evaluated the U.S. EPR non standard Technical Specifications for the CCWS (TS 3.7.7), which includes the thermal barrier common header and CCWS system leakage requirements, and finds the TS for CCWS has been adequately addressed and finds them acceptable. For the thermal barrier, this LCO is necessary to ensure, given a single failure, that the CCWS flow to the RCP thermal barrier will be maintain by at least one Operable CCWS division. For CCWS system leakage, the TS Surveillance Requirement is adequate to ensure CCWS system Operability given degraded conditions such as valve seat leakage, valve packing leakage and seal leakage is within the 7 day capacity of the CCWS surge tank.

9.2.2.4.2 ITAAC

FSAR Tier 1, Section 2.7.1 provides U.S. EPR design certification information and ITAAC for the CCWS. FSAR Tier 1 information for balance-of-plant SSCs is evaluated in Section 14.3.7 of this report, and evaluation of FSAR Tier 1 information in this section is an extension of the evaluation provided in Section 14.3.7 of this report. This evaluation pertains to plant systems aspects of the proposed FSAR Tier 1 information for CCWS.

Important aspects of the CCWS design include the significant safety-related functions. These include:

- The transport of the heat from the safety injection system (SIS) and residual heat removal system (RHRS) to the ESWS.
- Cooling of the thermal barrier of the RCP seals during all plant operating modes when the RCPs are running. There is a cross-connect in the header that supplies cooling to the RCP thermal barriers to allow thermal barrier cooling from either CCWS Common 1.b or 2.b headers.
- Heat removal from the safety chilled water system (SCWS) Divisions 2 and 3.
- Removal of the decay heat from the fuel pool cooling water heat exchanger.

- Containment isolation valves close upon receipt of a containment isolation signal.
- CCWS pump has adequate NPSH and adequate water deliver to important safety related equipment.

The staff reviewed the descriptive information, safety-related functions, arrangement, mechanical, I&C and electric power design features, environmental qualification, as well as system and equipment performance requirements provided in FSAR Tier 1, Section 2.7.1 to confirm completeness and consistency with the plant design basis as described in FSAR Tier 2, Section 9.2.2. The staff also reviewed FSAR Tier 1, Tables 2.7.1-1, 2.7.1-2, 2.7.1-3, and Figure 2.7.1-1. The staff finds that all the necessary CCWS equipment has been identified in the applicable tables. The staff concludes that if the ITAAC for CCWS are performed and the acceptance criteria met, there is reasonable assurance that a plant that incorporates the design certification has been constructed and will be operated in conformity with the design certification, the provisions of the Atomic Energy Act of 1954, and NRC regulations which includes 10 CFR 52.47(b)(1).

9.2.2.4.3 Initial Test Program

FSAR Tier 2, Section 14.2.12.5.5 describes the initial test program for the CCWS. Section 14.2 of this report addresses the staff's evaluation of the initial test program for U.S. EPR CCWS.

9.2.2.5 *Combined License Information Items*

There are no COL information items specified in FSAR Tier 2, Table 1.8-2 for this area of review. No additional COL information items need to be included in FSAR Tier 2, Table 1.8-2 for component cooling water system consideration.

9.2.2.6 *Conclusions*

The staff evaluated the CCWS for the U.S. EPR standard plant design in accordance with the guidance that is referred to in the Regulatory Basis Section 9.2.2.3 of this report. The staff's review included information in the FSAR as supplemented by the applicant's response to numerous RAI which have been incorporated in Interim Revision 3 of the FSAR used for this report.

For the reasons set forth above, the staff finds that the applicant appropriately identified maximum credited CCWS heat removal capabilities and maximum credited CCWS flow rates for individual safety-related components, as well as for the system as a whole in various relevant modes of operation. The staff finds that the U.S. EPR four safety-related division design with a minimum of two divisions required provides inherent tolerance to single failures.

The staff review also included consideration of the CCWS ITAAC, preoperational testing, and technical specifications, and finds that these sections provided reasonable assurance that the CCWS will be inspected, tested, and operated in accordance with the CCW system design basis.

Based on the review summarized above, and the resolution of one outstanding confirmatory item related to RAI 465, Question 9.2.1-51, the staff concludes that the CCWS design complies with the guidance of NUREG-0800, Section 9.2.2; and that the information provided by the applicant adequately demonstrates that the design satisfies the requirements of 10 CFR Part 50, Appendix A, GDC 2, GDC 4, GDC 44, GDC 45, GDC 46, and 10 CFR 20.1406. In addition, the staff concludes that if the ITAAC for CCWS are performed and the acceptance criteria met, there is reasonable assurance that a plant that incorporates the design certification has been constructed and will be operated in conformity with the design certification, provision of the Atomic Energy Act of 1954, and NRC regulations which include 10 CFR 52.47(b)(1). As previously stated in this evaluation, other sections of this report are referenced and appropriate discussion and the staff's evaluations are found in these sections.

9.2.3 Demineralized Water Distribution System

The demineralized water distribution system (DWDS) stores water in the demineralized water storage tanks and delivers it to the various systems and components in the power plant. For the U.S. EPR, none of the users of demineralized water depend on the system for safety-related functions or backup.

The staff's evaluation related to the DWDS containment isolation features is described in Section 6.2.4 of this report.

The staff's evaluation related to verifying that non-safety-related SSCs, including the DWDS, do not reduce the function of safety-related SSCs during and after a safe shutdown earthquake is described in Section 3.7 of this report.

The staff's evaluation of whether the DWDS design complies with 10 CFR 20-1406, "Minimization of Contamination," is addressed in Section 12.3 of this report.

9.2.4 Potable and Sanitary Water Systems

9.2.4.1 *Introduction*

The potable and sanitary water systems (PSWS) provide water for general purposes throughout the plant. The water is used for human consumption, sanitary and domestic purposes. It is also a water source for other systems inside the Nuclear Island and the Conventional Island. Makeup water for the potable and sanitary water systems is site-specific and is pretreated at the source to meet applicable water quality standards.

9.2.4.2 *Summary of Application*

FSAR Tier 1: FSAR Tier 1, Section 2.7.10, "Potable and Sanitary System," states that there are no FSAR Tier 1 entries for the PSWS.

FSAR Tier 2: The PSWS are described in FSAR Tier 2, Section 9.2.4, "Potable and Sanitary Water Systems." The systems provide potable and sanitary water for the plant. The PSWS have no safety function or safety-design basis. However, design requirements are applied to ensure that failure of the systems does not result in failure of nearby safety-related equipment.

Potable and sanitary water is pretreated to meet the site-specific water quality standards. The processing of raw water makeup for potable and sanitary water is site-specific. A combined license applicant that references the U.S. EPR design certification will provide site-specific details related to the sources and treatment of makeup to the potable and sanitary water systems along with a P&ID.

ITAAC: FSAR Tier 2, Table 14.3-8, “Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC) Screening Summary,” (Sheet 3 of 7) shows the PSWS as being within the scope of FSAR Tier 1. The table also indicates that the PSWS do not have an FSAR Tier 1, ITAAC.

Technical Specifications: There are no technical specifications associated with the PSWS.

9.2.4.3 *Regulatory Basis*

The relevant requirements of NRC regulations for this area of review, and the associated acceptance criteria, are given in NUREG-0800, Section 9.2.4, “Potable and Sanitary Water Systems,” and are summarized below. Review interfaces with other SRP sections also can be found in NUREG-0800, Section 9.2.4.

1. 10 CFR 50, Appendix A, GDC 60, “Control of Releases of Radioactive Materials to the Environment,” as it relates to design provisions provided to control the release of liquid effluents containing radioactive material from contaminating the potable and sanitary water system.

2. 10 CFR 52.47(b)(1), “Contents of applications; technical information,” as it relates to the requirement that a design certification application contain the proposed ITAAC that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a plant that incorporates the design certification is built and will operate in accordance with the design certification, the provisions of the Atomic Energy Act of 1954, and NRC regulations.

9.2.4.4 *Technical Evaluation*

Reviews of the FSAR and supporting FSAR Tier 2 information are performed in accordance with guidance provided in NUREG-0800, Section 9.2.4. Information that addresses the requirements of GDC 60 in regard to controlling radioactive effluent releases is considered acceptable if the following are met:

- There are no interconnections between the PSWS and systems having the potential for containing radioactive material.

- The potable water system is protected by an air gap, where necessary.

- An evaluation of potential radiological contamination, including accidental, and safety implications of sharing (for multi-unit facilities) indicates that the system will not result in contamination beyond acceptable limits.

The PSWS provide potable and sanitary water for the plant. The systems supply water for consumption and sanitary use, and are also used by other systems as a water source inside the Nuclear Island and the Conventional Island. Water is pretreated to meet site-specific water quality specifications during all plant conditions. The PSWS also include water heaters to provide hot water where needed.

The PSWS transfers the water from the site-specific source to various systems and components throughout the plant. As previously noted, the applicant considers the system P&ID to be the responsibility of the COL applicant. The staff finds this reasonable, since the site-specific makeup water source will determine details of the water source and treatment measures.

During all plant conditions, the PSWS supply the necessary pretreated water for consumption and sanitary flushing purposes. During abnormal operating conditions, such as loss of offsite power, the systems will not be available.

The potable and sanitary water systems perform no safety functions. Accordingly, the components and piping are classified by FSAR Tier 2, Table 3.2.2-1, “Classification Summary,” as Quality Group E, which corresponds to non-safety and non-seismic. In accordance with FSAR Tier 2, Section 3.2.2, “System Quality Group Classification,” this quality classification was assigned for systems and components that do not fit into the standard definitions of Quality Groups A through D as defined by RG 1.26, “Quality Group Classifications and Standards for Water Steam and Radioactive Waste Containing Components for Nuclear Power Plants.” FSAR Tier 2, Section 3.2.2 states that Quality Group E systems and components are designed to meet the relevant commercial or industrial standards. The staff agrees that the PSWS components have been appropriately classified since the PSWS is not considered important to safety and RG 1.29, Regulatory Position C.2 for the non-safety-related portions of the PSWS have been adequately addressed with respect to seismic classification.

In FSAR Tier 2, Section 9.2.4, the applicant states that layout of the system piping and valves is designed so that a failure of any component or equipment of the PSWS does not compromise the operation of safety-related equipment. Additionally, two remotely operated isolation valves are provided to limit flooding in the Safeguard Buildings, Elevation +15 feet and above. Closure of these valves mitigates the potential for flooding of the Safeguard Building by the PSWS. The automatic closure of these two isolation valves is actuated by a MCR water leakage detection system signal (located near the toilet areas). Flooding mitigation is evaluated by the staff in Section 3.4.1, “Flood Protection,” of this report.

In the FSAR, the applicant states that the PSWS is not connected to any other process systems which could become contaminated. Contamination with potentially radioactive material is prevented by separation of the PSWS piping, vents, and valve arrangements from other plant chemical and radiological systems. In RAI 87, Question 09.02.04-1, the staff requested that the applicant confirm compliance with GDC 60 relative to the degree of PSWS separation from radiological processes and how this prevents contamination and protects against potential radiological backflow into the PSWS. In a February 6, 2009, response to RAI 87, Question 09.02.04-1, the applicant stated that there are no interconnections between the PSWS piping and other piping that conveys radioactive materials. Furthermore, the applicant indicated that where plant chemical processes, treatments, or drainage conditions are involved, the PSWS is protected from contamination by the installation of backflow prevention measures, such as reduced pressure backflow prevention devices or air gaps. The staff finds the applicant’s response and the associated markup of FSAR Tier 2, Section 9.2.4 comply with GDC 60 with respect to preventing contamination of the PSWS by radioactive water. **RAI 87, Question 09.02.04-1 is being tracked as a confirmatory item**.

ITAAC: There are no ITAAC associated with the PSWS. The staff reviewed these systems against the guidance in SRP Section 14.3.7, “Plant Systems - Inspections, Tests, Analyses, and Acceptance Criteria,” and agrees that no ITAAC are required for the PSWS.

Inspection and Testing Requirements: Prior to initial plant startup, a preoperational test is performed. The test is intended to demonstrate the ability of the PSWS to supply potable and sanitary water as designed during normal plant operation. The PSWS are tested as described in FSAR Tier 2, Section 14.2, Test No. 225, “Potable and Sanitary Water Systems.” The staff finds the test an acceptable means to verify the system will perform as stated in FSAR Tier 2, Section 9.2.4.

Technical Specifications: FSAR Tier 2, Chapter 16, “Technical Specifications” are not applicable to the PSWS.

9.2.4.5 *Combined License Information Items*

Table 9.2.4-1 provides a list of PSWS related COL information item numbers and descriptions from FSAR Tier 2, Table 1.8-2:

Table 9.2.4-1 U.S. EPR Combined License Information Items

Item No.	Description	FSAR Tier 2 Section
9.2-2	A COL applicant that references the U.S. EPR design certification will provide site-specific details related to the sources and treatment of makeup to the potable and sanitary water system along with a simplified piping and instrument diagram.	9.2.4.2

The staff finds the above listing to be complete. Also, the list adequately describes actions necessary for the COL applicant. No additional COL information items need to be included in FSAR Tier 2, Table 1.8-2 for PSWS consideration.

9.2.4.6 *Conclusions*

The PSWS information provided by the applicant in FSAR Tier 2, Section 9.2.4, as well as the February 6, 2009, response to RAI 87, Question 09.02.04-1 were reviewed based on the applicable guidance contained in NUREG-0800, Section 9.2.4. The staff finds that the applicant has provided sufficient information and concludes that the proposed design is acceptable. Therefore, the staff considers that the applicant has complied with GDC 60 with respect to preventing contamination of the PSWS by radioactive water. **RAI 87, Question 09.02.04-1 is being tracked as a confirmatory item** to verify that the appropriate FSAR changes are made.

9.2.5 Ultimate Heat Sink

9.2.5.1 *Introduction*

The UHS functions to dissipate heat rejected from the ESWS during normal operating, accident, and shutdown conditions. The UHS includes four independent, redundant, safety-related, dual cell mechanical draft cooling towers, and four cooling tower basins. Each cooling tower basin is sized to provide enough water inventory to support ESWS operation for a minimum of 72 hours without the need for makeup during DBA conditions. Normal makeup water sources ensure the 72-hr water supply is maintained during normal operations. Emergency makeup water sources provide additional water supply to the basin for up to 30 days following an accident. The basin and makeup sources (emergency and normal) provide the cooling water source for the ESWS. One of the four cooling towers (Division 4) can also function to remove heat from the non-safety-related dedicated ESWS division for severe accidents (SA). In the event two UHS divisions are unavailable (e.g., due to preventative maintenance in one division and a single failure in another division), the remaining two UHS divisions have the ability to achieve the safe-shutdown state under a design-basis accident as each UHS division is sized to handle 50 percent of the maximum credited cooling capacity. The system interface heat loads include the CCWS heat exchangers, EDG heat exchangers, essential service water (ESW) pump room coolers, and the dedicated non-safety CCWS heat exchanger. Each safety-related division is powered by an ASME Code Class 1E electrical bus with emergency power available from the EDG for its respective division.

Except for confirming that the separate non-safety dedicated division will not adversely impact the capability of the safety-related divisions to perform their safety functions, evaluation of the dedicated division is not included within the scope of this evaluation. The dedicated division is used for mitigating severe accidents and is reviewed in Chapter 19, "Probalistic Risk Assessment," of this report.

9.2.5.2 *Summary of Application*

In a February 18, 2011, response to RAI 465, Question 09.02.01-51, the applicant provided FSAR Interim Revision 3, which provided markups of the information provided in FSAR Revision 2 that is related to the UHS. Therefore, the application as reviewed by the staff in this section consists of information provided in FSAR Revision 2, as supplemented by the markups provided by FSAR Interim Revision 3.

FSAR Tier 1: FSAR Tier 1, Interim Revision 3, Section 2.7.11, "Essential Service Water System," describes the most important attributes of the design of both the ESWS and the UHS. The functional arrangement of the UHS portion of the ESWS is shown in FSAR Tier 1, Figure 2.7.11-1, "Essential Service Water System Functional Arrangement," Sheets 6 to 9. Mechanical design information is provided in FSAR Tier 1, Table 2.7.11-1, "Essential Service Water System Equipment Mechanical Design," which provides system component physical locations, functions, ASME Code Class, Section III applicability and seismic category. Instrument, control, and electrical design information including power supplies, control, and display locations is identified in FSAR Tier 1, Table 2.7.11-2, "Essential Service Water System Equipment I&C and Electrical Design."

FSAR Tier 2: FSAR Tier 2, Interim Revision 3, Section 9.2.5 and Figure 9.2.5-1, "Ultimate Heat Sink Piping and Instrumentation Diagram," sets forth the design basis and a detailed description of the USG. Each safety-related UHS cooling tower division contains two cooling tower cells, with a multi-speed vital bus powered fan, a tower basin shared between cells, and basin support design features. The support features provide the capabilities for basin blowdown (BD), safety-related emergency basin makeup, non-safety-related (NSR) normal makeup, and chemical addition.

As stated above, the four UHS cooling towers and the associated systems and components serve to transfer heat from each of four separate ESWS divisions to the environment. Each UHS ESWS divisional pair division is a functional part of the overall U.S. EPR four safety-division design. This design provides sufficient redundancy such that the UHS retains the capability to transfer the design basis heat load from the ESWS to the environment in the event of a single failure of one safety division with a second division out of service for maintenance.

The UHS cooling towers are housed in four independent, safety-related Seismic Category I Essential Service Water Buildings. In addition to the cooling towers, each EWSB houses an attached Essential Service Water Pump Building (ESWPB). The four ESWBs are located in pairs on each side of the NI complex. The pairs of buildings are separated to protect them from being simultaneously affected by external events such as aircraft hazards and explosion pressure waves. Initial plant testing of the UHS is described in FSAR Tier 2, Section 14.2, Special Test No. 49, “Ultimate Heat Sink.”

ITAAC: Inspections, tests, analyses, and acceptance criteria for the UHS portion of the ESWS are included in FSAR Tier 1, Table 2.7.11-3, “Essential Service Water System ITAAC.”

Technical Specifications: Technical specifications for the UHS are provided in FSAR Tier 2, Chapter 16, TS Section 3.7.19, “Ultimate Heat Sink (UHS).”

U.S. EPR Plant Interfaces: This section of the application contains information related to the plant interface requirements that will be addressed in the COL applications: These include support systems such as emergency makeup water for the UHS.

9.2.5.3 *Regulatory Basis*

The relevant requirements of NRC regulations for this area of review, and the associated acceptance criteria, are specified for the most part in NUREG-0800, Section 9.2.5, “Ultimate Heat Sink,” and are summarized below. Review interfaces with other SRP sections also can be found in NUREG-0800, Section 9.2.5.

1. GDC 2, “Design Basis for Protection Against Natural Phenomena,” as it relates to the capabilities of structures housing the system and the system itself having the capability to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, floods, tsunami, and seiches without loss of safety-related functions.

2. GDC 4, “Environmental and Dynamic Effects Design Bases,” as it relates to effects of missiles inside and outside containment, effects of pipe whip, jets, environmental conditions from high- and moderate-energy line-breaks, and dynamic effects of flow instabilities and attendant loads (e.g., water hammer) during normal plant operation, as well as upset or accident conditions.

3. GDC 5, “Sharing of Structures, Systems, and Components,” insofar as it requires that SSCs important to safety not be shared among nuclear power units unless it can be shown that sharing will not significantly impair their ability to perform their safety functions.

4. GDC 44, “Cooling Water,” as it relates to the capability to transfer of heat from systems, structures, systems, and components important to safety to an ultimate heat sink during both normal and accident conditions, with suitable redundancy, assuming a single active component failure coincident with either the loss of offsite power or loss of onsite power.

5. GDC 45, “Inspection of Cooling Water System,” as it relates to design provisions for inservice inspection of safety-related components and equipment.

6. GDC 46, “Testing of Cooling Water System,” as it relates to design provisions for pressure and operational functional testing of cooling water systems and components in regard to

    - o Structural integrity and system leak-tightness of its components

- o Operability and adequate performance of active system components

- o Capability of the integrated system to perform credited functions during normal, shutdown, and accident conditions

7. 10 CFR 52.47, “Contents of applications; technical information,” Item (b)(1), which requires that a design certification application contain the proposed ITAAC that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a facility that incorporates the design certification has been constructed and will be operated in accordance with the design certification, the provisions of the Atomic Energy Act, and NRC regulations.

8. 10 CFR 20.1406, “Minimization of Contamination,” as it relates to the standard plant design certifications and how the design and procedures for operation will minimize contamination of the facility and the environment facilitate eventual decommissioning and minimize to the extent practicable, the generation of radioactive waste.

Acceptance criteria adequate to meet the above requirements include:

- RG 1.29, “Seismic Design Classification,” March 2007, (Seismic Design Criteria), Regulatory Position C.1 for safety-related and Regulatory Position C.2 for non-safety-related portions of the UHS.

9.2.5.4 *Technical Evaluation*

The staff’s evaluation of the UHS is based upon the information provided in a February 18, 2011, response to RAI 465, Question 9.2.1-51, that transmitted FSAR Tier 2 markups as Interim Revision 3 for Section 9.2.5 and for other FSAR sections as referred to below.

The staff requested that the applicant respond to questions in 32 RAIs which were based on the information in FSAR Tiers 1 and 2, Revisions 0, 1, and 2 that described the design, operation, and testing of the UHS. The applicant answered these questions in numerous responses that included FSAR markups which the staff reviewed and finds acceptable because the applicant clarified how the system works, resolved apparent in consistencies and provided the necessary detail for the staff to review. In RAI 465, Question 9.2.1-51, the staff requested that the applicant compile and submit an FSAR markup that incorporated all the FSAR markups that were submitted separately as part of the responses to the 32 RAIs. In a February 18, 2011, response to RAI 465, Question 09.02.01-51, the applicant provided an Interim Revision 3 FSAR markup for the applicable sections. The staff reviewed the February 18, 2011, response to RAI 465, Question 09.02.01-51, and confirmed that all of the UHS RAI response markups had been successfully incorporated in the FSAR markup, with the exception of one additional confirmatory item (RAI 502 Question 09.02.05-37), that is discussed in Section 9.2.5.4.3 of this report. In this report, the staff is not describing each RAI and the information provided by the applicant in responses to each RAI; rather, the evaluation in this section is based on the staff’s review of the interim FSAR Revision 3 markup for the applicable sections, which includes all the information that was submitted in response to the original 32 RAIs for the UHS. In some cases, the staff may discuss the applicant’s RAI responses where clarifying information that is not described in the FSAR was provided. To ensure that information gets included in the FSAR, **RAI 465, Question 09.02.01-51 and RAI 502, Question 09.02.05-37 are being tracked as confirmatory items.**

In addition, Section 9.2.5.4.2 of this report describes one open item related to technical specifications.

9.2.5.4.1 System Design Considerations

GDC 2

The UHS must be capable of withstanding the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, floods, and external missiles without loss of capability to perform its safety functions in accordance with GDC 2 requirements. Analyses, design features, and provisions that are credited for satisfying GDC 2 requirements are described in FSAR Tier 2, Chapter 3, "Design of Structures, Components, Equipment and Systems," Sections 3.2, "Classification of Structures, Systems, and Components," through 3.11, "Environmental Qualification of Mechanical and Electrical Equipment," as applicable, that address the specific hazard considerations. Consequently, the staff's evaluations of these analyses, design features, and provisions are provided in the corresponding Chapter 3 sections of this report (i.e., Sections 3.2 through 3.11 of this report). The staff confirmed that the seismic designation of safety- and non-safety-related parts of the UHS are properly specified in accordance with RG 1.29, "Seismic Design Classification," such that the analyses, design features, and provisions that are described in FSAR Tier 2, Chapter 3 (as evaluated in the corresponding sections of this report) will ensure that the UHS is capable of performing its safety functions during and following the occurrence of natural phenomena. Based on the criteria specified in FSAR Tier 2, Section 3.2, essential parts of the UHS should be designated as safety-related, Seismic Category I, Quality Group C and controlled in accordance with the requirements established by 10 CFR Part 50, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants." The staff reviewed the P&IDs for the UHS and determined that essential parts of the system (including the cooling tower structure and boundary isolation valves) are properly designated as safety-related, Seismic Category I, Quality Group C and that non-essential parts are properly designated as non-safety-related. The staff confirmed that this information is correctly reflected in FSAR Tier 2, Table 3.2.2-1, "Classification Summary," and that 10 CFR Part 50, Appendix B requirements are appropriately specified for the safety-related parts of the system.

The UHS cooling tower fill is constructed of ceramic tile, supported on reinforced concrete beams. The UHS cooling tower internals are seismically designed and supported to withstand the safe-shutdown earthquake. Also, because each of the safety-related UHS divisions, including the cooling tower fans, has its own safety-related emergency power source that is protected from the effects of natural phenomena as described in FSAR Tier 2, Chapter 3, the loss of offsite power as a result of natural phenomena will not adversely affect the capability of the UHS to perform its safety functions.

The UHS fans are designed to withstand the effects of a tornado including differential pressure effects, overspeed, and the impact of differential pressure effects on other equipment located within the cooling tower structures. As stated in FSAR Tier 2, Section 9.2.5.3.1, "Mechanical Draft Cooling Towers," the method to be used to protect the UHS fans from overspeed due to tornado effects will be a brake system or the resistance provided by the fan gear reducer.

FSAR Tier 2, Section 3.5.2, "Structures, Systems, and Components to be Protected from Externally Generated Missiles," states that the ESWB, including underground piping, cables and instrumentation between the ESWB and other safety-related SSCs, is missile protected and meet the guidance in RG 1.27, "Ultimate Heat Sink." Any above ground piping and components (including ceramic fill) are protected by the safety-related structures. Non-seismic lines and associated equipment are routed, to the extent possible, outside of safety-related structures and areas to prevent any adverse interactions. In the event that this routing is not possible and non-seismic lines must be routed in safety-related areas, the non-seismic items are evaluated for seismic interactions as described in FSAR Tier 2, Section 3.7.3.8, “Interaction of Non-Seismic Category I Subsystems.” The staff evaluation is documented in Section 3.7.3 of this report. In addition, the cooling tower fans have missile shields to protect the fans from missiles in case any missiles enter through the top of the Seismic Category I cooling towers as discussed in FSAR Tier 2, Section 3.8.

Cooling tower basin volume is credited to support the first 72 hours of post-accident UHS cooling tower operation. Potential volume losses through boundary valve seat leakage are addressed by boundary valve seat leak testing (LT) for all boundary isolation valves as described in the inservice valve testing program in FSAR Tier 2, Section 3.9.6.3, “Inservice Testing Program for Valves.” The acceptable leakage rates for these valves are based on the ASME Operating and Maintenance (OM) Code and ensure a sufficient UHS basin volume during the first 72 hours of an accident.

In the event of torrential rains and hurricanes, water could enter through the air inlet and air outlet areas of the cooling tower portion of the ESWB. As the water level reaches a predetermined high level, an alarm in the control room will alert the operator. Operator action is performed to remove water from the cooling tower basin through the use of the safety-related emergency blowdown system as described in FSAR Tier 2, Section 9.2.1, “Essential Service Water System,” to maintain normal water level. Therefore, no adverse effects on the safety-related equipment within the ESW pump room will occur if the water level rises due to torrential rains and hurricanes.

FSAR Tier 2, Section 3.4, “Water Level (Flood) Design,” describes internal and external flood protection which includes consideration of flooding from the UHS system and which is evaluated in Section 3.4 of this report. Section 3.7 of this report further describes FSAR Tier 1 ITAAC, which ensure that the failure of non-safety-related SSCs, as installed, will not adversely impact the function of safety-related SSCs during and after a safe-shutdown earthquake. The staff finds this acceptable to ensure that non-safety portions will not impact safety-related portions by either using separation of non-safety SSCs or using Seismic II Category SSCs in proximity to safety-related portions.

In summary, the staff finds that the non-safety and safety-related parts of the UHS are properly classified such that the analyses, design features, and provisions described in FSAR Tier 2, Chapter 3 (as evaluated in the corresponding sections of this report), will ensure that the UHS is capable of performing its safety functions during and following the occurrence of the natural phenomena described in GDC 2. The design of these SSCs conforms to the guidance provided in RG 1.29 and RG 1.27 for meeting GDC 2 requirements. Therefore, the staff finds that the UHS system satisfies the requirements specified in GDC 2.

<u>GDC 4</u>

The UHS must be adequately protected from dynamic effects due to equipment failures and external environmental conditions and must be capable of performing its safety functions over the entire range of environmental conditions associated with normal operations, maintenance, testing, and postulated accidents in accordance with GDC 4 requirements. Since the UHS is directly connected to the ESWS, the two systems can produce dynamic effects (such as water hammer) that can directly affect each other. Analyses, design features, and provisions that are credited for satisfying GDC 4 requirements (for both ESWS and UHS) are described primarily in

FSAR Tier 2, Sections 3.4, “Water Level (Flood) Design)”; 3.5, “Missile Protection”; 3.6, “Protection Against Dynamic Effects Associated with Postulated Rupture of Piping”; 3.8, “Design of Category I Structures”; and 3.11. The staff evaluations of these analyses, design features, and provisions are provided in the corresponding sections of this report. As discussed in the section above regarding GDC 2 requirements, the staff has confirmed that the safety- and non-safety-related parts of the UHS are properly classified such that the analyses, design features, and provisions described in FSAR Tier 2, Sections 3.4, 3.5, 3.6, 3.8, and 3.11 will ensure that the UHS is adequately protected from dynamic effects and capable of performing its safety functions in accordance with GDC 4 requirements.

The staff reviewed the ESWS description in FSAR Tier 2, Section 9.2.1 to confirm that the applicant has adequately addressed water hammer considerations that could affect the UHS. Additionally, GDC 4 requires safety-related SSCs to be able to accommodate the effects of discharging fluids resulting from postulated high and moderate energy pipe failures. Pipe diameters for all branches of the UHS piping are based on limiting the flow velocity to 3.05 m/sec (10 ft/sec) for normal modes of operation that are expected to occur frequently. The makeup water flow to the cooling tower basin automatically stops once the water level in the cooling tower basin rises to the pre-set high limit in either an operating or standby division. If the water level in the cooling tower basin continues to rise, an alarm will alert the operator at the high level. Operator action will be performed to remove water from the cooling tower basin through the use of the safety-related emergency blowdown lines to maintain normal water level. Water from the emergency blowdown lines is discharged outside of the building and is located above the flood level. The emergency blowdown pipe exiting the building is protected from tornado generated missiles by the building structure. Since the UHS divisions are physically separated, any other postulated piping failure in one division would not affect any of the other divisions.

In summary, the staff finds that the design of the UHS complies with GDC 4 since the UHS is adequately protected from dynamic effects (including water hammer) due to equipment failures and external environmental conditions and is capable of performing its safety functions over the entire range of environmental conditions associated with normal operations, maintenance, testing, and postulated accidents in accordance with GDC 4 requirements.

GDC 5

The applicant must demonstrate that the sharing of SSCs between nuclear power units will not significantly impair the capability of the UHS to perform its safety functions in accordance with GDC 5 requirements. The U.S. EPR standard plant design is a single-unit station, and consequently there are no shared safety-related SSCs between different units. Therefore, the provisions of GDC 5 are not applicable to the U.S. EPR standard plant design.

GDC 44

As described in Section 9.2.5.1 of this report, the UHS functions to dissipate heat rejected from the ESWS during normal operating, accident, and shutdown conditions. The safety-related ESWS pumps cooling water from the cooling tower basin to components that reject heat to the ESWS and then back to the mechanical draft cooling tower. The cooling tower, through the use of spray nozzles and fill, increases the exposed surface area of the water to the ambient air forced over it by the cooling fans. The heat is transferred through the evaporation process as the water returns to the basin. The UHS should be capable of providing sufficient cooling for at least 30 days to permit safe-shutdown and cooldown of the plant and to maintain the plant in a safe-shutdown condition during the worst 30-day period based on regional (site-specific) meteorological data taken over a span of 30 years, which conforms to the guidance in RG 1.27. For the U.S. EPR UHS design, the guidance in RG 1.72, "Spray Pond Piping made from Fiberglass," for spray ponds is not applicable, because cooling towers are used in lieu of spray ponds with piping components made from fiberglass-reinforced thermosetting resin. Also, because each of the safety-related UHS divisions has its own safety-related emergency power source, each of which is protected from the effects of natural phenomena, as described in FSAR Tier 2, Chapter 3, the loss of offsite power as a result of natural phenomena will not adversely affect the capability of the UHS to perform its safety functions.

The UHS design parameters are given in FSAR Tier 2, Table 9.2.5-2, "Ultimate Heat Sink Design Parameters." FSAR Tier 2, Figure 9.2.5-1 shows the UHS piping and instrumentation diagram. Parts of the blowdown system (normal and emergency) and dedicated ESWS are shown in FSAR Tier 2, Figure 9.2.1-1, "Essential Service Water System Piping & Instrumentation Diagram." The UHS consists of four independent, redundant, safety-related divisions which are each sized to remove 50 percent of the DBA heat load from the ESWS. The safety-related ESWS heat loads that the UHS transfers to the atmosphere are shown in FSAR Tier 2, Table 9.2.5-1, "Ultimate Heat Sink System Interface." For DBA conditions, the UHS is credited with maintaining ESW supply water less than 35 °C (95 °F) throughout the accident. Normal operating conditions and technical specifications provide added margin to the DBA condition by requiring the UHS to maintain the ESW supply water temperature to less than 32.2 °C (90 °F).

Each of the four safety-related UHS divisions consists of one dual cell, mechanical draft cooling tower with two fans, spray nozzles, tower fill, wind drift eliminator, piping, valves, controls, and instrumentation. Each safety-related division also includes a cooling tower basin intake structure with removable coarse and fine safety-related screens that cover the width of the pump bay opening and extend above the maximum water level to provide full coverage. The screens protect the ESWS pumps and ESWS and UHS system components from debris. A differential water level setpoint across each screen is provided and continuously monitored in the control room. Each screen's (high) differential pressure setpoint has an alarm in the control room to alert operators that the screen needs to be inspected and cleaned. Each UHS division has two cells (each with its own fan) that share one common basin. Both cells need to be operable for the division to be able to remove 50% of the credited heat load during an accident.

A dedicated, non-safety-related division of ESWS/UHS is provided for cooling the severe accident heat removal system (SAHRS) heat exchanger to address severe accident considerations as described in FSAR Tier 2, Chapter 19, "PRA and Severe Accident." While the non-safety dedicated division includes a completely separate ESWS division (in addition to the four ESWS safety divisions), the safety-related Division 4 UHS cooling tower is used by the non-safety-related dedicated division of ESWS for transferring severe accident heat loads to the environment under worst-case ambient conditions. The dedicated division of ESWS does not affect the safety-related function of the UHS as it is isolated from the safety-related portions unless needed during severe accident conditions. As described in FSAR Tier 2, Section 9.2.5.3, "Component Description," each division of UHS is independent of the other divisions. The four division design of the UHS provides complete redundancy such that a single failure will not compromise the UHS system safety-related functions. Assuming unavailability of one division due to preventative maintenance and another due to single failure, the two remaining UHS divisions can achieve safe-shutdown from DBA conditions. For loss of offsite power events, each of the four divisions of UHS cooling towers has power supplied by its respective division's EDG. In turn, should the loss of on site power occur, each of the four divisions of UHS cooling towers has sufficient power supplied by off site power.

The UHS cooling towers will operate for a nominal 72 hrs following a LOCA without the need for adding any makeup water to the basin. The tower basin is sized to contain at least a 72-hr supply of water (8,357 m^3 (295,120 ft^3)) during operation. The normal makeup water supply line maintains this volume during normal operation and prior to any accident occurring. If an accident were to occur, the normal makeup water supply line is isolated and the water volume in the basin is used to support ESWS operation for at least 72 hours.

The applicant established the minimum cooling tower basin water volume based on the worst-case environmental conditions, highest ESWS heat load during a DBA for a 72-hr period, and sufficient margin to prevent vortex formation and to maintain adequate NPSH for the ESW pumps. Inventory losses consist of evaporation losses, tower drift losses, valve seat leakage, and seepage. A margin of 15.24 cm (6 in.) was applied for the minimum pump submergence and a 25.40 cm (10 in.) margin for the 72-hour water volume. The design drift loss from the UHS tower is 0.005 percent of total water volume; however, a conservative 0.01 percent was used in the analysis. Valve leakage is calculated assuming all isolated valves leak simultaneously at the maximum rate allowed under the TS (i.e., a maintained rate of 4.8D Lpm (0.5 D gpm)), where D is the nominal valve diameter in cm (in.). This is consistent with the ASME OM IST acceptance criteria. The 30-day seepage loss is 163,293 kg (360,000 lbm) and a 3-day seepage loss of 18,144 kg (40,000 lbm) was chosen for this analysis. This analysis also assumes that ESW pumps operate at design flow for the 72-hour duration. A water level of 53.34 cm (21 in.) is provided above the minimum level required by the Technical Specifications to account for the operating band and instrument margins. Also, 15.24 cm (6 in.) is provided for freeboard. FSAR Tier 2, Figure 9.2.5-3, illustrates the basin cross-section design values. The staff believes this margin is sufficient based on operational experience.

After 72 hours, UHS makeup water to the basin is provided by a safety-related emergency makeup water system which will be described in detail by COL applicants. High and low level alarms are provided to annunciate in the control room to aid operators. FSAR Tier 2, Table 9.2.5-3, “Design Values for Maximum Evaporation and Drift Loss of Water from the UHS,” shows meteorological design values for maximum evaporation and drift losses over 72 hours. A conservative extrapolation is made from this data to determine the 1,135 Lpm (300 gpm) emergency makeup water flow rate credited for the next 27 days. Each COL applicant must demonstrate that the site characteristics (e.g., wet bulb temperature) fall within the postulated site parameters specified in FSAR Tier 2, Table 9.2.5-3 or justify a departure from the site parameter, UHS cooling tower normal and emergency blowdown is automatically isolated during the initial 72-hour post-accident period through system instrumentation and control design features to help prevent loss of inventory. Design meteorological conditions that result in the minimum cooling tower cooling performance for the first 24 hours of a DBA are shown in FSAR Tier 2, Table 9.2.5-4, “Design Values for Minimum Water Cooling in the UHS.” Under these worst case conditions, the UHS still provides cooling water to the ESWS less than 35 °C (95 °F) for the duration of the DBA. Each COL applicant must demonstrate that the site characteristics (e.g., wet bulb temperature) fall within the postulated site parameters specified in FSAR Tier 2, Table 9.2.5-4 or justify a departure from the site parameter,

The staff evaluated interference and recirculation effects as follows: To account for potential recirculation and interference effects between cooling towers and other systems, an inlet wet bulb correction factor is used. With respect to interference effects, site factors including orientation (with respect to wind direction), location, and wind velocity and direction are considered. With respect to recirculation effects, factors including the site layout are considered. The site-specific wet bulb correction factor will be applied when evaluating the applicability of the UHS design parameters provided in FSAR Tier 2, Table 9.2.5-2. If the site-specific zero percent exceedance maximum non-coincident wet bulb temperature exceeds the value provided in FSAR Tier 2, Table 9.2.5-2 when the site-specific wet bulb correction factor is applied, then a site-specific evaluation will be performed to demonstrate the acceptability of the UHS design for the site-specific conditions as described in Section 9.2.5.5 of this report. Depending on site layout and site meteorological conditions, the UHS cooling tower could have interference effects that would impact nearby safety-related air intakes. A COL applicant that references the U.S. EPR design certification will perform an evaluation of the interference effects of the UHS cooling tower on nearby safety-related air intakes. This evaluation will confirm that potential UHS cooling tower interference effects on the safety-related air intakes does not result in air intake inlet conditions that exceed the U.S. EPR Site Design Parameters for Air Temperature as specified in FSAR Tier 2, Table 2.1-1, "U.S. EPR Site Design Envelope." Accordingly, in view of the above the staff finds that interference and recirculation effects are adequately addressed.

To account for potential adverse weather effects, the staff evaluated the following: Each UHS cooling tower division has two cells, each with its own 250 horsepower fan powered by ASME Code Class 1E electrical buses. The fans have multi-speed drives that are also capable of fan operation in the reverse direction. Reverse direction operation for brief periods can help minimize ice build-up at air intakes during cold weather. When a cooling tower fan is operated in the reverse direction to eliminate ice build-up, the system (associated division) is considered operable. Upon receipt of an SI signal, any fan(s) operating in the reverse direction will automatically trip and re-start following coast-down, and accelerate to full speed in the forward direction to dissipate the maximum heat to the environment. The time to change from reverse fan operation to full speed forward is less than 5 minutes. Considering the low ambient environmental temperatures that would exist in order to initiate reverse fan operation (i.e., well below design cooling water temperatures), there is sufficient margin to allow for this short delay. Similarly, upon receipt of a safety injection signal, cooling tower fans in the standby division(s) will automatically start and accelerate to full speed, and the cooling tower fans in the operating division(s) will continue to operate at full speed. If the fans in the operating division(s) are operating at reduced speed at the onset of a DBA, they will be automatically switched to full speed upon receipt of an SI signal, to dissipate the maximum heat to the environment. All of these actions are automatic following the receipt of an SI signal and do not rely upon operator action. The staff finds this adequate because the fans will automatically start when needed during an accident

Each UHS division has a variety of freeze protection design features in addition to reverse fan operation. First, each UHS division has a cooling tower bypass line which can divert full ESWS flow directly back to the UHS basin. In addition, pumps, piping, valves, and other components essential to the operation of the UHS are located within the boundary of the ESWPB, except the short section of emergency blowdown pipe exiting the building that is normally void of water. As stated in FSAR Tier 2, Section 9.4.11, "Essential Service Water Pump Building Ventilation System," the ESWPB ventilation system maintains a minimum temperature above freezing. The system design also utilizes self-draining spray nozzles that are attached to the header immediately after the header exits the ESWPB. As needed, any other piping and components subject to freezing conditions are provided with freeze protection design features, such as heat tracing.

FSAR Tier 2, Table 9.2.5-5, "Ultimate Heat Sink – Initial Chemistry to be Maintained at the Start of a DBA," provides UHS water chemistry parameters to ensure that the UHS cooling towers will be able to perform their safety function. A COL applicant that references the U.S. EPR design certification will compare site-specific chemistry data for normal and emergency makeup water to the parameters in FSAR Tier 2, Table 9.2.5-5. If the specific data for the site fall within the assumed design parameters in FSAR Tier 2, Table 9.2.5-5, then the U.S. EPR standard design is bounding for the site. For site-specific normal and emergency makeup water data or characteristics that are outside the bounds of the assumptions presented in FSAR Tier 2, Table 9.2.5-5, the COL applicant will provide an analysis to confirm that the U.S. EPR UHS cooling towers are capable of removing the design-basis heat load for a minimum of 30 days without exceeding the maximum specified temperature limit of the ESWS and minimum required basin water level as described in Section 9.2.5.5 of this report. In addition, the applicant has stated that the tower fill spacing is chosen to minimize the buildup of biofilm and provide for ease of cleaning and maintenance. System materials that come into contact with one another are chosen to minimize galvanic corrosion.

Based on the foregoing, the staff finds that the UHS has the heat removal capacity to remove the DBA heat load from the ESWS and the required redundancy to address single failure scenarios. In addition, the UHS has sufficient emergency power supplies, freeze protection, chemistry controls, and NPSH margin for the ESWS pumps. The minimum UHS water volume requirements ensure no additional makeup water is needed for the first 72 hours of a DBA. Emergency makeup water post 72 hours is a COL information item discussed in Section 9.2.5.5 of this report. On the basis of the above discussion, the staff finds that the UHS complies with the requirements of GDC 44 for providing cooling water and heat removal from the ESWS.

GDC 45

FSAR Tier 2, Section 9.2.5.1, “Design Basis,” states that the UHS is designed to permit appropriate periodic inspection and testing of important components to provide assurance of the integrity and capability of the system in accordance with GDC 45. Similarly, FSAR Tier 2, Section 9.2.5.6, “Inspection and Testing Requirements,” states that the installation and design of the UHS provides accessibility for the performance of periodic testing and inservice inspection with limited personnel exposure. Inservice inspection and testing requirements are in accordance with the ASME B&PV Code, Section XI and the ASME OM Code. FSAR Tier 2, Section 3.9, “Mechanical Systems and Components,” and FSAR Tier 2, Section 6.6, “Inservice Inspection of Class 2 and 3 Components,” outline the inservice testing and inspection requirements. Design considerations for the safety-related portions of the UHS and provisions for monitoring of UHS heat rejection capability to confirm adequate performance over time will be as indicated in FSAR Tier 2, Section 9.2.1.6 concerning GL 89-13, “Service Water System Problems Affecting Safety-Related Equipment,” July 1989. The inspections will include periodic inspections of the UHS cooling tower basins to identify macroscopic biological fouling organisms, such as blue mussels, American oysters and Asiatic clams, sediment and corrosion, biocide treatment of the system, flushing and flow testing of redundant and infrequently used cooling loops and equipment, and periodic sampling. Chemical treatment with the appropriate biocide(s) will be performed in response to positive biological fouling test results, and the frequency of treatment will be adjusted as appropriate. Biocide treatment will be in accordance with applicable Federal, State, and local environmental regulations.

Based on the ability to inspect the cooling towers with limited personnel exposure and the commitments to inservice and GL 89-13 inspections, the staff finds that sufficient provisions have been established to meet GDC 45 requirements.

GDC 46

As stated in the review of GDC 45 requirements above, FSAR Tier 2, Section 9.2.5.6 indicates that periodic inspection and testing will be performed with ASME Section XI and the ASME OM

Code. Piping and components in the UHS, that are subject to inservice inspection and testing are identified in FSAR Tier 2, Table 3.2.2-1; inservice testing requirements are described in FSAR Tier 2, Section 3.9.6, "Functional Design, Qualification, and Inservice Testing Programs for Pumps, Valves, and Dynamic Restraints," and FSAR Tier 2, Table 3.9.6-2, "Inservice Valve Testing Program Requirements"; and inservice inspection requirements are discussed in FSAR Tier 2, Section 6.6. In addition, the UHS divisions are in continuous operation during all plant modes with each UHS division being operated on a rotational schedule to even equipment wear or tested periodically in accordance with technical specifications (TS). Because the system is designed such that these TS surveillances can be accomplished, the staff concludes that the requirements of GDC 46 are satisfied.

10 CFR 20.1406, "Minimization of Contamination"

The requirements of 10 CFR 20.1406 states that an applicant for standard plant design certifications needs to describe how the facility design and procedures for operation of the facility will minimize, to the extent practicable, contamination of the facility and the environment, as well as the generation of radioactive waste. The ESWS design is consistent with the containment management philosophy to comply with the requirements of 10 CFR 20.1406, as described in FSAR Tier 2, Section 12.3.6, "Minimization of Contamination." FSAR Tier 2, Section 12.3.6 describes the approach used in designing systems to minimize the cross-contamination of non-radioactivity in the environment. The UHS is directly connected to the ESWS, which is free of radioactivity resulting from plant operation. Radioactive leaks and fluid would need to breach heat exchanger barriers between the primary systems and the CCWS in addition to the CCWS/ESWS heat exchanger barrier before it could potentially reach the UHS. Radiation monitors are present in the CCWS to detect contamination migrating into or out of the system. To detect CCWS/ESWS heat exchanger leakage, each ESWS division plus the dedicated ESWS have radiation monitors downstream of the CCWS heat exchanger. The placement of monitors at these locations represents the closest point of potential system cross-contamination. With two barriers and radiation monitors between the UHS and any potential radioactivity leakage, the UHS is unlikely to become contaminated, and no additional radiation monitors in the UHS design are deemed necessary. Migration of radioactivity to the UHS from potentially radioactive systems is prevented with a minimum of two barriers, namely, the ESWS and CCWS. The ESWS supplies water to the CCWS heat exchangers and returns the water to the UHS cooling tower basins, which are part of a non-radioactive system. The ESWS is monitored such that if the CCWS should contain radioactive material and leak into the ESWS, such leakage would be detected early and could be remediated. The staff's evaluation of the design features of the associated radiation monitoring systems and sampling provisions are presented in Sections 11.5 and 12.3.6 of this report. Detection of radioactivity into and out of the CCWS/ESWS will allow a licensee to take action to minimize contamination of the facility, prevent unmonitored and uncontrolled releases of radioactivity, and minimize the generation of radioactive waste. Therefore, the staff concludes that the UHS design, as described in the FSAR, is unlikely to become contaminated and complies with 10 CFR 20.1406 and NRC guidance.

9.2.5.4.2 Technical Specifications

TS 3.7.19 provides LCO and surveillance requirements (SRs) for the UHS. TS requirements are evaluated in Chapter 16 of this report to confirm consistency with the Standard TS (STS) requirements. The U.S. EPR Technical Specifications were developed utilizing Revision 3.1 of the STS, NUREG-1430, "Standard Technical Specifications - Babcock and Wilcox Plants," NUREG-1431, "Standard Technical Specifications - Westinghouse Plants," NUREG-1432, “Standard Technical Specifications - Combustion Engineering Plants,” and NUREG-1434, “Standard Technical Specifications - General Electric Plants (BWR/6),” as deemed appropriate. The staff reviewed UHS design and operational considerations in this section to confirm that they are adequately reflected in the proposed TS requirements and to assure that the TS Bases are reflective of the TS requirements that are proposed. The staff’s evaluation of TS 3.7.8, “Essential Service Water (ESW) System,” requirements that pertain to the ESWS is provided in Section 9.2.1 of this report.

In addition, TS 3.7.19 requires entry into a 120-day LCO if one cooling tower division is inoperable and entry into a 72-hour LCO if two cooling tower divisions are inoperable. TS SR 3.7.19.1 and 3.7.19.2 require daily cooling tower basin level and temperature verification, respectively. These surveillances are adequate to verify that these variables are within their prescribed ranges, so that the operators can determine whether the UHS is operable or not; however, NRC regulations 10 CFR 50.36(c)(2)(ii) states that a technical specification limiting condition for operation of a nuclear reactor must be established for each item meeting one or more of the following criteria: (C) Criterion 3, A structure, system, or component that is part of the primary success path and which functions or actuates to mitigate a design basis accident or transient that either assumes the failure of or presents a challenge to the integrity of a fission product barrier.

> The US EPR standard plant uses a mechanical draft cooling tower (MDCT) for its ultimate heat sink (UHS). Regulatory Position 4 from Regulatory Guide (RG) 1.27 (1976), “Ultimate Heat Sink for Nuclear Power Plants,” states, in part, that the technical specifications for the plant should include provisions for actions to be taken in the event that conditions threaten partial loss of the capability of the UHS. Thus, the staff needs assurance that the assumptions used to calculate the UHS cooling capability bound actual conditions. Since the ambient WB temperature greatly influences the heat removal capacity and efficiency of the MDCT and affects all four trains of the UHS, which is used to protect fission product barriers. For this reason, in RAI 518, Question 09.02.05-38, the staff requested that the applicant address the following:
>
> a. Describe in the US EPR FSAR the condition of the UHS that would exist if the ambient WB temperature exceeds the UHS design basis 81° F WB temperature.
>
> b. Describe in the RAI response the UHS WB temperature margins.
>
> c. Describe if the existing US EPR TS surveillance requirements (SR) of <90° F is bounding and if the limited conditions of operations (LCO), would be entered if the ambient WB temperature exceeds 81° F (Table 9.2.5-2), exceeds 78.72° F (Table 9.2.5-3), or exceeds 85.3° F (Table 9.2.5-4).
>
> d. Describe in the US EPR TS Bases how the ambient WB temperature is addressed by TS and how it is measured and on what frequency.
>
> e. Describe applicable combined license (COL) information items that are required to address ambient WB temperature.

RAI 518, Question 09.02.05-38 is being tracked as an Open Item.

Chapter 16 of this report addresses the staff's evaluation of the UHS to assure that the proposed TS LCO and associated Bases adequately address and reflect system-specific design considerations as described in FSAR Tier 2, Section 9.2.5, and evaluated above in Section 9.2.5.4 of this report.

9.2.5.4.3 ITAAC

FSAR Tier 1, Section 2.7.11, provides U.S. EPR design certification information and ITAAC for the ESWS and UHS. FSAR Tier 1 information for balance-of-plant SSCs is evaluated in Section 14.3.7 of this report, and evaluation of FSAR Tier 1 information in this section is an extension of the evaluation provided in Section 14.3.7 of this report. This evaluation pertains to plant systems aspects of the proposed FSAR Tier 1 information for the UHS. Plant-systems aspects of proposed FSAR Tier 1 information for the ESWS are evaluated in Section 9.2.1of this report.

The staff reviewed the descriptive information, arrangement, design features, environmental qualification, performance requirements, and interface information provided in FSAR Tier 1, Section 2.7.11 to confirm completeness and consistency with the plant design basis as described in FSAR Tier 2, Section 9.2.5. The staff also reviewed FSAR Tier 1, Table 2.7.11-1, Table 2.7.11-2, Table 2.7.11-3, and Figure 2.7.11-1. The staff determined that FSAR Tier 1 information was incomplete, inaccurate, or that clarification is needed with respect to UHS ITAAC testing. Therefore, in RAI 175, Question 09.02.05-18, the staff requested that the applicant address this concern. In a July 31, 2009, response to RAI 175, Question 09.02.05-18, the applicant did not provide sufficient information to address the staff's concerns regarding all the UHS testing needed to ensure that the UHS is installed and constructed in accordance with the approved design. Therefore, in follow-up RAI 351, Question 09.02.05-31, the staff requested that the applicant address the remaining staff concerns. Specifically, the staff requested that ITAAC be added to confirm that the cooling towers, under worst case design conditions including site-specific meteorological data, are capable of removing the design basis heat load over a 30-day period and maintain the minimum water level required by TS. In a November 4, 2010, response to follow-up RAI 351, Question RAI 09.02.05-31, the applicant added two new ITAAC to FSAR Tier 1, Table 2.7.11-3 (shown as Tests 7.9 and 7.10 in FSAR Interim Revision 3). While the two new ITAAC attempt to address the staff's concern, the wording of, "assuming the worst case design conditions," in the acceptance criteria is ambiguous and does not provide clarity that this includes the worst site-specific 30-day meteorological data over the previous 30-year history in accordance with RG 1.27. The clarity is important to ensure that future COL applicants understand that the ITAAC must include this site-specific data adjustment. Therefore, the staff asked supplemental RAI 502, Question 9.2.5-37 to address this concern. On September 2, 2011, the applicant responded to this RAI and clarified the language in their ITAAC to include the worst case meteorological conditions as requested. Therefore, RAI 502, Question 09.02.05-37 is being tracked as a confirmatory item.

9.2.5.4.4 Initial Test Program

Applicants for combined licenses must provide plans for pre-operational testing and initial operations in accordance with 10 CFR 52.79(a)(28), "Contents of applications; technical information," requirements. FSAR Tier 2, Section 14.2.12.5.8, "Ultimate Heat Sink (Test #049)," describes the initial test program for the UHS.

Section 14.2 of this report addresses the staff's evaluation of the initial test program for the UHS.

9.2.5.5 *Combined License Information Items*

Table 9.2.5-1 provides a list of ultimate heat sink related COL information item numbers and descriptions from FSAR Tier 2, Table 1.8-2:

Table 9.2.5-1 U.S. EPR Combined License Information Items

Item No.	Description	FSAR Tier 2 Section
9.2-1	A COL applicant that references the U.S. EPR design certification will provide site-specific information for the UHS support systems such as makeup water, blowdown, and chemical treatment (to control biofouling).	9.2.5.2
9.2-5	A COL applicant that references the U.S. EPR design certification will provide a description of materials that will be used for the UHS at their site location, including the basis for determining that the materials being used are appropriate for the site location and for the fluid properties that apply.	9.2.5.2
9.2-6	A COL applicant that references the U.S. EPR design certification will confirm by analysis of the highest average site-specific wet bulb and dry bulb temperatures over a 72-hr period from a 30-yr hourly regional climatological data set that the site-specific evaporative and drift losses for the UHS are bounded by the values presented in Table 9.2.5-3.	9.2.5.3
9.2-7	A COL applicant that references the U.S. EPR design certification will confirm that the maximum UHS cold-water return temperature of 95 °F is met by an analysis that confirms that the worst combination of site-specific wet bulb and dry bulb temperatures over a 24-hr period from a 30-yr hourly regional climatological data set are bounded by the values presented in Table 9.2.5-4	9.2.5.3

Item No.	Description	FSAR Tier 2 Section
9.2-8	A COL applicant that references the U.S. EPR design certification will confirm that the UHS makeup capacity is sufficient to meet the maximum evaporative and drift water loss after 72 hrs through the remainder of the 30-day period consistent with RG 1.27.	9.2.5.3
9.2-9	A COL applicant that references the U.S. EPR design certification will compare site-specific chemistry data for normal and emergency makeup water to the parameters in Table 9.2.5-5. If the specific data for the site fall within the assumed design parameters in Table 9.2.5-5, then the U.S. EPR standard design is bounding for the site. For site-specific normal and emergency makeup water data or characteristics that are outside the bounds of the assumptions presented in Table 9.2.5-5, the COL applicant will provide an analysis to confirm that the U.S. EPR UHS cooling towers are capable of removing the design basis heat load for a minimum of 30 days without exceeding the maximum specified temperature limit for ESWS and minimum basin water level required by TS..	9.2.5.2
9.2-11	A COL applicant that references the U.S. EPR design certification will perform an evaluation of the interference effects of the UHS cooling tower on nearby safety-related air intakes. This evaluation will confirm that potential UHS cooling tower interference effects on the safety-related air intakes does not result in air intake inlet conditions that exceed the U.S. EPR Site Design Parameters for Air Temperature as specified in Table 2.1-1.	9.2.5.3.1

The staff finds the above listing to be complete. Also, the list adequately describes actions necessary for the COL applicant. No additional COL information items need to be included in FSAR Tier 2, Table 1.8-2 for ultimate heat sink consideration.

9.2.5.6 *Conclusions*

The staff evaluated the UHS for the U.S. EPR standard plant design in accordance with the guidance that is referred to in Section 9.2.5.3, "Regulatory Basis," of this report. The staff's review included information in the FSAR as supplemented by the applicant's responses to numerous RAIs which have been incorporated in Interim FSAR Revision 3 which the staff reviewed for this report.

The staff finds that the applicant appropriately identified maximum heat loads and design requirements for individual safety-related components, as well as for the system as a whole in various relevant modes of operation. The staff also finds that the U.S. EPR four safety-related division design with a minimum of two divisions required can perform its safety function in the event of the most severe postulated single failure.

The staff's evaluation also included the UHS ITAAC, pre-operational testing and technical specifications and the staff finds that these sections provide reasonable assurance that the UHS will be inspected, tested and operated in accordance with the UHS system design basis RAI 502 , Question 09.02.05-37 is being tracked as a confirmatory item pending addition of the proposed language into FSAR Tier 1, Section 2.7.11, ITAAC Tests 7.9 and 7.10 to include the worst case, site-specific meteorological data as discussed in Section 9.2.5.4.3 of this report.

Except for RAI 518, Question 09.02.05-38, which is being tracked as an open item, RAI 465, Question 09.02.05-51 (Interim Revision 3), and RAI 502, Question 09.02.05-37, which are being tracked as confirmatory items, and based on the review summarized above, the staff concludes that the UHS design complies with the guidance of NUREG-0800, SRP Section 9.2.5 and that the information provided shows that the design complies with the requirements of 10 CFR Part 50, Appendix A, GDC 2, GDC 4, GDC 44, GDC 45, GDC 46,and 10 CFR 20.1406. The proposed ITAAC requirements need clarification, as discussed in Section 9.2.5.4.3 of this report, and as discussed in RAI 351, Question 09.02.05-31, to meet the requirements of 10 CFR 52.47(b)(1).

9.2.6 Condensate Storage Facilities

The staff reviewed FSAR Tier 2, Section 9.2.6, "Condensate Storage Facilities." This section states:

> The U.S. EPR stores condensate in the condenser hotwell and in the demineralized water storage tank. None of the users of demineralized water depend on the hotwell or the demineralized water storage tank for safety-related functions or backup.

SRP Section 9.2.6, "Condensate Storage Facilities," addresses the guidance for condensate storage facilities. A typical U.S. PWR uses a condensate storage tank (CST) as the preferred source of water for the emergency feedwater system (EFWS) pumps, and when the CST is depleted, the water source for the pumps is typically switched to the safety-related plant service water system. For the U.S. EPR design, there is no CST source of water for the EFWS pumps, because the EFWS storage pools serve as the water supply source.

The design of the EFWS storage pools is included in FSAR Tier 2, Section 10.4.9, "Emergency Feedwater System." The staff evaluated the EFWS storage pools design against SRP Section 9.2.6. The results of the staff's review of the EFWS storage pools and compliance with SRP Section 9.2.6 is included in Section 10.4.9 of this report.

9.2.7 Seal Water Supply System

9.2.7.1 *Introduction*

The seal water supply system (SEWSS) supplies seal water to equipment and components in systems carrying radioactive fluids to prevent the escape of radioactive fluids from the shaft seals of pumps and agitators. The SEWSS also feeds the sealing liquid tanks of the gaseous waste processing system and the piping of the operational chilled water system. The SEWSS system consists of two pumps, two buffer tanks, and associated valves and piping. The SEWSS utilizes nitrogen charged buffer tanks to assure seal water availability during abnormal operation of the charging pumps and the severe accident heat removal system (SAHRS) pump.

The seal water supply system performs non-safety-related functions and is, therefore, classified non-safety-related.

9.2.7.2 *Summary of Application*

FSAR Tier 1: There are no FSAR Tier 1 entries for this system as stated in FSAR Tier 1, Section 2.7.4, "Seal Water Supply System."

FSAR Tier 2: FSAR Tier 2, Section 9.2.7, "Seal Water Supply System," describes the SEWSS. The SEWSS system is shown in FSAR Tier 2, Figure 9.2.7-1, "Seal Water Supply System." Initial plant testing of the SEWSS is described in FSAR Tier 2, Section 14.2.12.5.3, "Seal Water Supply System (Test No. 045)."

ITAAC: There are no inspection, test, analysis, and acceptance criteria items for this area of review.

Technical Specifications: There are no Technical Specifications for this area of review.

9.2.7.3 *Regulatory Basis*

The staff determined that no current NUREG-0800 section is directly applicable to the SEWSS. In order to facilitate evaluation of FSAR Tier 2, Section 9.2.7, the staff selected applicable portions of SRP Section 9.2.1, "Essential Service Water System," SRP Section 9.2.2, "Component Cooling Water," and SRP Section 10.3.4, "Turbine Gland Sealing System," as guidance. However, some of the guidance in these SRP sections was not applicable to the SEWSS.

The acceptance criteria contained in these three SRP sections which are applicable to the SEWSS include:

1. GDC 2, "Design Basis for Protection Against Natural Phenomena," as it relates to the capability of the design to maintain and perform its safety function following an earthquake or other natural phenomena.

2. GDC 60, "Control of Releases of Radioactive Materials to the Environment," as it relates to the control of releases of radioactive materials to the environment.

3. 10 CFR 20.1406, "Minimization of Contamination," as it relates to the minimization of contamination of the facility and the environment.

9.2.7.4 *Technical Evaluation*

The staff's evaluation of the SEWSS is based upon the information provided in FSAR Tier 2, Section 9.2.7 and in other FSAR sections, as referred to below. The SEWSS is shown in FSAR Tier 2, Figure 9.2.7-1.

9.2.7.4.1 System Design Considerations

<u>GDC 2</u>

GDC 2 requires SSCs important to safety to be protected from natural phenomena such as seismic events. Although the seal water supply system is non-safety-related, FSAR Tier 2, Section 9.2.7 indicates that it contains piping and components in Safeguard Building 4 and the FB, which include other safety-related equipment. As such, in FSAR Tier 2, Section 9.2.7.1, "Design Basis," the applicant states that the seal water supply system performs no safety-related functions and is classified as non-safety-related. Additionally, the SEWSS is in a non-seismic category, excluding portions of the system located within Safeguard Building 4 and the FB. However, the staff review of both the system functional diagram (i.e., FSAR Tier 2, Figure 9.2.7-1) and FSAR Tier 2, Table 3.2.2-1, "Classification Summary," Sheets 104 to 107, determined only non-seismic piping and components were identified. The staff also noted that the functional diagram was incorrectly referenced as FSAR Tier 2, Figure 9.2.12-1. Therefore, in RAI 163, Question 09.02.02-1, the staff requested that the applicant address this issue.

In a March 20, 2009, response to RAI 163, Question 09.02.02-1, the applicant indicated that the non-seismic classification of the portions of the SEWSS in Safeguard Building 4 and the FB were considered correct in FSAR Tier 2, Table 3.2.2-1 and Figure 9.2.7-1. The applicant further explained that non-seismic lines and associated equipment are routed, to the extent possible, outside of safety-related structures and areas.

Designating a particular non-safety-related component as Seismic Category II (as stated in RG 1.29, "Seismic Design Classification," Regulatory Position C.2) depends on the component's potential failure modes, proximity of Seismic Category I/safety-related components, and the vulnerability of these components to the failure mode consequences. In the event these lines must be routed in safety-related areas, the non-seismic items are evaluated for seismic interactions (refer to FSAR Tier 2, Section 3.7.3.8, "Interaction of Other Systems with Seismic Category I Systems"). The applicant also stated that failure of the non-safety-related non-seismic portions of the SEWSS does not prevent or degrade the safety function of any safety-related Seismic Category I component.

The staff reviewed the March 20, 2009, response to RAI 163, Question 09.02.02-1 and determined that FSAR Tier 2, Section 3.7.3.8.2, "Interaction Evaluation," indicates that unrestrained, non-Seismic Category I SSC may be located in the vicinity of safety-related SSC provided an impact evaluation is performed and it is determined that functionality of the safety-related SSC is not lost as a result of impact. In this evaluation, the non-Seismic Category I components are assumed to fall or overturn as a result of a seismic event. Any safety-related subsystem or component which may be impacted by the non-Seismic Category I component is identified as an interaction target and is evaluated to establish that there is no loss of ability to perform its safety-related function.

The staff concludes that the SEWSS non-seismic Category I SSCs that potentially present a hazard are relocated or restrained; therefore, the guidance of RG 1.29, Regulatory Position C.2 is satisfied.

In addition to the above explanation, the applicant provided a markup of FSAR Tier 2, Section 9.2.7.1 in an effort to maintain consistency between the FSAR text and the classification of SEWSS components in FSAR Tier 2, Table 3.2.2-1 and FSAR Tier 2, Figure 9.2.7-1. The markup also eliminated an incorrect reference to FSAR Tier 2, Figure 9.2.12-1 as identified in RAI 163, Question 09.02.02-1. The staff finds the applicant's explanation and discussion related to RG 1.29, Regulatory Position C.2, and the proposed FSAR markup, are adequate since it clarifies that the SEWSS performs no safety-related functions and is classified as non-safety related and non-seismic. The staff confirmed that Revision 1 of the FSAR, dated May 29, 2009, contains the changes committed to in the RAI response. Accordingly, the staff finds that the applicant has adequately addressed this issue and, therefore, considers RAI 163, Question 09.02.02-1 resolved, and GDC 2 satisfied in that failure of the SEWSS due to severe natural phenomena will not cause the failure of safety-related SSCs. In addition, Section 3.7.3, "Seismic Subsystem Analysis," of this report evaluates non-seismic components interactions with safety-related SSCs.

<u>GDC 60 and 10 CFR 20.1406</u>

The staff questioned whether the potential existed for intrusion of radioactive process system water into individual seal water supply lines, since system check valves did not appear to be provided for each component. In addition, although the applicant stated that the SEWSS had direct connections to potentially radioactive components, no discussion of compliance with GDC 60 was provided. Therefore, in RAI 163, Question 09.02.02-2, the staff requested that the applicant address these and other related questions as follows:

1. The regulatory bases of SEWSS should be explained, especially with respect to GDC 60 and the requirements specified by 10 CFR 20.1406. Revise other sections of the FSAR as appropriate to reflect this information, such as FSAR Tier 2, Section 3.1.6.1, "Criterion 60 – Control of Releases of Radioactive Materials to the Environment."

2. Justify why SEWSS is needed to the pump seals (e.g., provide seal cooling, prevent leakage of radioactive fluid, prevent air in-leakage).

3. Identify any equipment that has continuous seal water leak-off flow, and describe the potential for this flow to be contaminated and the prevention of the release of radioactive material by the design.

4. Describe the prevention of the intrusion of radioactive process system water into individual seal water supply lines, since system check valves are not shown in the seal water supply to each component in FSAR Tier 2, Figure 9.2.7-1.

5. Describe the capability of the design to detect contamination of the SEWSS and to monitor the release of radioactive material from the SEWSS.

6. Justify the satisfaction of the requirements specified by 10 CFR 20.1406 by the SEWSS design.

7. Describe the consequences of a loss of SEWSS.

In a March 29, 2009, response to RAI 163, Question 09.02.02-2, the applicant responded to each of the seven subparts as follows:

1. The SEWSS is free of radioactivity, and its design is consistent with the requirements of 10 CFR 20.1406, as described in FSAR Tier 2, Section 12.3.6, "Minimization of Contamination." Radioactive material release from potentially radioactive systems is prevented with a minimum of two barriers, which are provided by an arrangement of check valves between SEWSS system users and the demineralized water system.

2. FSAR Tier 2, Section 9.2.7 states: "The SEWSS supplies seal water to equipment and components in systems carrying radioactive fluids to prevent the escape of radioactive fluids from the shaft seals of pumps and agitators."

3. Mechanical pump seals use seal water in conjunction with the seal design to prevent the pumped fluid from escaping to the environment and are designed to operate with no wet seal water leak-off, which significantly reduces the potential for contamination. Specific pump seal characteristics of SEWSS users and the amount of continuous seal water leak-off flow will be developed later in the design process.

4. The SEWSS operates at a higher pressure than its downstream users. Intrusion of radioactive process system water into individual user supply lines is prevented by the users receiving an "off" command on low seal water header pressure. As shown on FSAR Tier 2, Figure 9.2.7-1, check valves prevent backflow from the users.

   Check valve 30GHW46AA002 prevents backflow from users in the Radioactive Waste (Processing) Building (RWB).

   Check valve 30GHW45AA003 prevents backflow from the CVCS charging pump seals.

   Check valve 30GHW44AA003 prevents backflow from the severe accident heat removal system pump seals.

   Check valves 30GHW11/12AA002 prevent backflow to the seal water pumps and recirculation flow path to the demineralizer tanks.

   Check valve 30QNB61AA006 (not shown) prevents backflow from the operational chilled water user.

   Check valve 30KPL20AA201 (not shown) prevents backflow from the gaseous waste processing (supply to tanks).

5. Contamination monitoring for the SEWSS is not required, as it is free of radioactivity. This condition is maintained by two barriers, provided by check valves in series, between SEWSS system users and the demineralized water system.

6. Refer to the response to Part 1 for how the SEWSS complies with 10 CFR 20.1406.

7. In the event of a loss of SEWSS, a low pressure trip initiates a protection "off" to the seal water users and the buffer tanks' solenoid isolation valves close. Each buffer tank user continues to be supplied from the buffer tanks. The consequences of SEWSS loss to an individual user (e.g., the CVCS charging pump grace period) will be determined later in the design process.

The staff determined that the applicant's March 29, 2009, response to RAI 163, Question 09.02.02-2, Part 1, was not complete. As discussed in the response to RAI 163, Question 09.02.02-2, Part 2 above, a major function of the SEWSS is to provide a pressurized source of demineralized water in order to prevent leakage of radioactive fluids from pump and agitator shaft seals. The applicant states that the SEWSS is free of radioactivity and the design is consistent with 10 CFR 20.1406, since a minimum of two barriers is provided by an arrangement of check valves between SEWSS system users and the demineralized water system. The check valves described by the applicant do separate the demineralized water tanks from contamination potential from SEWSS; however, the staff observed that in the event of a loss of system pressure (e.g., pump failure) the check valves do not eliminate the potential for back leakage of radioactive fluid into local SEWSS piping. For example, in the radwaste area, only a single check valve is shown on FSAR Tier 2, Figure 9.2.7-1, Sheet 1

(30GHW46 AA002) in a common SEWSS supply line serving over 20 interconnected Radwaste Building systems or components. Therefore, in case of loss of supply pressure, the potential exists for circulation of radioactive seal leakage between running and idle equipment through common supply piping. The staff also noted that the applicant's March 29, 2009, response to RAI 163, Question 09.02.02-2, Part 4 above, describes an automatic trip of systems of components served by the SEWSS in the Radwaste Building on loss of seal water pressure. Consequently, it is not clear that the interlock can be credited for elimination of the potential for contamination of common lines by recirculation between components. Furthermore, seal failure could also occur if seal supply pressure was lost and a component supplied by the SEWSS remained in operation. The staff confirmed the applicant's discussion in regard to 10 CFR 20.1406, in FSAR Tier 2, Section 12.3.6.1.1, "Compartmentalization," which states that potentially radioactive systems that interface with nonradioactive systems are designed to have a minimum of two barriers to prevent spread of radioactivity to the non-radioactive system. However, the staff noted the example cited in this section (i.e., "[t]he component cooling water system (CCW)) is between the essential cooling water (ECW) system and the residual heat removal (RHR) system." The staff determined that the two barriers separating the ESWS from the RHR are the RHR and CCW heat exchangers, which are passive safety-related pressure boundaries. Furthermore, the CCWS system includes continuous radiation monitors. In contrast, the SEWSS is non-safety-related and includes direct connections to components in radioactive systems. Based on the above discussion, the staff concluded that some potential exists for contamination of SEWSS piping. Therefore, in follow-up RAI 337, Question 09.02.02-79, Part 1, the staff requested that the applicant address SEWSS potential contamination.

In a March 19, 2010, response to follow-up RAI 337, Question 09.02.02-79, Part 1, the applicant stated that check valves will be added to each user that currently does not have a check valve installed and FSAR Tier 2, Table 3.2.2-1 and FSAR Tier 2, Section 9.2.7.2.2, "Component Description," will be revised to reflect the function of these check valves. FSAR Tier 2, Figure 9.2.7-1 will also be revised to show the placement of these check valves.

The staff reviewed the applicant's March 19, 2010, response to RAI 337, Question 09.02.02-79, Part 1, and the markup of FSAR Tier 2, Figure 9.2.7-1 and determined that they were not acceptable, because some of the user loads to various subsystems do not have check valves; therefore, the staff generated an additional follow-up RAI 390, Question 09.02.02-106, Part a to address this item. In addition, follow-up RAI 390, Question 09.02.02-106, Part b identifies that FSAR Tier 2, Table 3.2.2-1 has an error which added 30GHW44 AA006, which does not exist on any FSAR figure.

In an October 15, 2010, response to follow-up RAI 390, Question 09.02.02-106, the applicant provided the following:

> Check valves were not added to the interfaces between the decontamination system for small machine components and the decontamination equipment for apparatus and vessels system users because these systems are not included in the FSAR. Check valves are located on the continuation of the figures for the remaining SEWSS users. The FSAR Tier 2 figures do not provide a level of detail that shows the interfaces between the SEWSS and the gaseous waste processing system, the operational chilled water system for gaseous waste processing system, and the liquid waste processing systems. Check valves are present in these systems. Their respective tag numbers are 30KPL20 AA201, 30QNB61 AA006, and 30KPF11 AA032.

Valve 30GHW44 AA006 was added to FSAR Tier 2, Table 3.2.2-1_Classification Summary by RAI 337, Supplement 2. This valve was removed during the final consistency review before submittal of FSAR Tier 2, Revision 2.

The staff reviewed the applicant's October 15, 2010, response to RAI 390, Question 09.02.02-106 (Parts a and b) and finds it acceptable because the check valves automatically close on reverse flow to mitigate potential radiation cross contamination with other components connected to the SEWSS and process piping during a loss of supply pressure. In addition, the check valves are installed as close as possible to such components to minimize the amount of piping that can be contaminated during reverse flow. Some check valves are not shown on the FSAR figures, since some systems are out of scope or the level of design details are not described in this application. In addition, the table error in FSAR Tier 2, Table 3.2.2-1 has been corrected with the issuance of FSAR Tier 2, Revision 2.

The staff confirmed that Revision 2 of the FSAR, dated August 31, 2010, contains the changes committed to in the applicant's responses to RAI 163, Question 09.02.02-2, Part 1; RAI 337, Question 09.02.02-79, Part 1; and RAI 390, Question 09.02.02-106, Parts a and b. Accordingly, the staff finds the applicant has adequately addressed these issues. Specifically, some check valves will be added to each user that currently does not have a check valve. In some cases, check valves are located on the continuation of the figures for the remaining SEWSS users. Check valves automatically close on reverse flow to mitigate potential radiation cross contamination. Therefore, the staff considers RAI 163, Question 09.02.02-2, Part 1; RAI 337, Question 09.02.02-79, Part 1; and RAI 390, Question 09.02.02-106, Parts a and b resolved.

The staff reviewed the applicant's March 29, 2009, response to RAI 163, Question 09.02.02-2, Part 2 and finds it acceptable, because the SEWSS supplies seal water to equipment and components in systems carrying radioactive fluids to prevent the escape of radioactive fluids from the shaft seals of pumps and agitators. Demineralized water supplied by the SEWSS at increased pressure to pump and agitator shaft seals was intended to prevent escape of radioactive fluids due to seal leakage. Since no other functions were identified by the applicant, the staff concluded that the function currently described in FSAR Tier 2, Section 9.2.7 was adequate; therefore, the staff considers RAI 163, Question 09.02.02-2, Part 2 resolved.

The staff reviewed the applicant's March 29, 2009, response to RAI 163, Question 09.02.02-2, Part 3 and finds it acceptable, because mechanical pump seals use seal water in conjunction with the seal design to prevent the pumped fluid from escaping to the environment and are designed to operate with no wet seal water leak-off, which significantly reduces the potential for contamination. Therefore, the staff considers RAI 163, Question 09.02.02-2, Part 3 resolved.

The staff reviewed the applicant's March 29, 2009, response to RAI 163, Question 09.02.02-2, Part 4 and finds it acceptable, because SEWSS operates at a higher pressure than the systems or components to which it supplies seal water. Intrusion of radioactive process system water from component seals into individual seal water supply lines is prevented by the components receiving an "off" command on low seal water header pressure. As shown on FSAR Tier 2, Figure 9.2.7-1, check valves prevent backflow from these components.

As previously discussed in RAI 163, Question 09.02.02-2, Part 1 (with the exception of single Radwaste Building check valve 30GHW46 AA002) the staff finds the individual path check valves given above are an acceptable means of limiting the potential for radioactive fluid intrusion into the SEWSS on loss of system pressure. Refer to the discussion in RAI 163, Question 09.02.02-2, Part 1 above in regard to the single Radwaste Building check valve. Accordingly, the staff considers the issue with the single radwaste area check valve resolved, since RAI 337, Question 09.02.02-79, Part 1 was resolved which added additional check valves to the SEWSS. Therefore, the staff considers RAI 163, Question 09.02.02-2, Part 4 resolved.

The staff reviewed the applicant's March 29, 2009, response to RAI 163, Question 09.02.02-2, Part 5 and determined it was unacceptable, because the response was incomplete and further discussion was needed in regard to provisions in the design for detection of potential contamination due to (1) radioactive fluid back leakage into interconnected radwaste area SEWSS supply piping and (2) potential component seal failure due to loss of SEWSS and failure of the non-safety equipment trip interlock. Therefore, in follow-up RAI 337, Question 09.02.02-79, Part 2, the staff requested that the applicant address these two issues.

In a March 19, 2010, response to RAI 337, Question 09.02.02-79, Part 2, the applicant stated that Item (1), radioactive fluid back leakage into interconnected radwaste area SEWSS supply piping, and the addition of check valves to each SEWSS user eliminates radioactive fluid back leakage into interconnected radwaste SEWSS supply piping. For Item (2), potential component seal failure due to loss of SEWSS and failure of the non-safety equipment trip interlock, the addition of check valves to each system or component connected to the SEWSS minimizes the resulting fluid loss due to a loss of SEWSS and concurrent failure of the non-safety-related equipment trip interlocks, because the check valves minimizes leakage of radioactive fluid back into the SEWSS. The fluid located downstream of the check valves may leak out of the failed seal onto the base plate of the pump. This fluid is collected by a lip plate on the base plate. The lip plate contains a level sensor to alarm operators that the pump is leaking seal fluid. Overflow seal leakage fluid is drained to the appropriate vent and drain system. Specific details of the lip plate and drain configuration will be finalized contingent upon selection of pump manufacturer and procurement of the pump.

The staff reviewed the applicant's March 19, 2010, response to RAI 337, Question 09.02.02-79, Part 2, and finds it acceptable, because the check valves automatically close on reverse flow to mitigate potential radiation cross contamination with other systems and components during a loss of supply pressure. In addition, the check valves are installed as close as possible to the user to minimize the amount of piping that can be contaminated during reverse flow and pump level sensor alarm based on sensed seal leakage in the event the pump seal fails. Therefore, the staff considers RAI 163, Question 09.02.02-2, Part 5, and RAI 337, Question 09.02.02-79, Part 2 resolved.

The staff reviewed the applicant's March 29, 2009, response to RAI 163, Question 09.02.02-2, Part 6 and finds it acceptable, because RAI 337, Question 09.02.02-79, Parts 1 and 2 (described above) adequately addressed the addition of check valves to prevent reverse flow. Therefore, the staff considers RAI 163, Question 09.02.02-2, Part 6 resolved.

The staff reviewed the applicant's March 29, 2009, response to RAI 163, Question 09.02.02-2, Part 7 and determined it was unacceptable, because, in the event of a loss of SEWSS any equipment that remains in operation without seal water would eventually experience seal failure and leakage of contaminated fluid. Each buffer tank user continues to be supplied from the buffer tanks. However, as discussed in regard to RAI 163, Question 09.02.02-2, Part 5 above and RAI 337, Question 09.02.02-79, Part 2, the applicant stated that the check valves automatically close on reverse flow to mitigate potential radiation cross contamination with other users and process piping during a loss of supply pressure. In addition, the check valves are installed as close as possible to the systems and components to minimize the amount of piping that can be contaminated during reverse flow. Also, pump level sensor alarm, which is based on sensed seal leakage, in the event the pump seal fails. The staff confirmed that Revision 2 of the FSAR, dated August 31, 2010, contains the changes committed to in the applicant's responses to RAI 337, Question 09.02.02-79. Accordingly, the staff finds that the applicant has adequately addressed this issue and, therefore, the staff considers RAI 163, Question 09.02.02-2, Part 7 resolved.

The two system buffer tanks are located in Safeguard Building 4 and the FB, respectively. These tanks function as accumulators in case of loss of power, since no backup power is provided, and are supplied from the plant demineralized water storage tanks by the seal water pumps through solenoid valves that are automatically controlled based on water level in the tanks. In FSAR Tier 2, Section 9.2.7.2.2, the applicant states that the buffer tanks provide a stored volume of seal water to supply the system users at sufficient pressure during LOOP conditions. Each buffer tank has a nitrogen gas cushion of sufficient pressure to provide the necessary seal pressure for any seal water level in the tank. Each buffer tank is protected from excessive nitrogen pressure by a safety valve in the nitrogen supply line. Further, FSAR Tier 2, Section 9.2.7.3.1, "System Operation," states that the valves downstream of the solenoid valves are adjusted and locked in the proper throttled position. Therefore, in RAI 163, Question 09.02.02-4, the staff requested that the applicant address the following five items related to the applicant's description of the buffer tanks:

1. The applicant's description in FSAR Tier 2, Section 9.2.7.2.2 implies that the seal water system as a whole can be supplied by the buffer tanks on a LOOP. However, only a small number of loads were found including the CVCS pump seals in the Fuel Building and the severe accident heat removal pump seals in Safeguard Building 4.

2. The safety valves that are described in FSAR Tier 2, Section 9.2.7.2.2 are not shown on FSAR Tier 2, Figure 9.2.7-1.

3. FSAR Tier 2, Figure 9.2.7-1 shows a valve downstream of the solenoid operated isolation valve that could be locked in the "throttled position" for only one of the two buffer tanks. The purpose of this valve needs to be described and an explanation is needed for why a valve is provided for only one of the buffer tanks.

4. A small seal pot is shown on FSAR Tier 2, Figure 9.2.7-1 in the level instrumentation for the buffer tank in Safeguard Building 4 but not on the FB buffer tank. Describe the purpose of this device and explain providing it for only one of the two buffer tanks.

5. Related to Item 4 above, describe the purpose for the Safeguard Building 4 buffer tank fill line bypass around the solenoid valve to the tank level instrumentation and verify it is not necessary on the FB buffer tank.

In a March 20, 2009, response to RAI 163, Question 09.02.02-4, the applicant responded to each of the five subparts as follows:

1. The buffer tanks provide a stored volume of seal water to the CVCS pump seals during normal plant operation and LOOP conditions, and to the severe accident heat removal system in the event of a severe accident. FSAR Tier 2, Section 9.2.7.2.2 will be revised to reflect this information.

2. The safety valves that protect the buffer tanks from excessive nitrogen pressure are located in the nitrogen supply line. These valves are not shown on FSAR Tier 2, Figure 9.2.7-1, because they are outside of the seal water system boundary and are part of the central gas distribution system.

3. Isolation valve 30GHW45 AA005 downstream of the solenoid-operated isolation valve is normally open. However, this valve can be closed to isolate the buffer tank for maintenance or in the event of tank failure. A valve is not provided downstream of the solenoid-operated isolation valve (30GHW44 AA002), because the severe accident heat removal pump seal is only supplied by seal water from the buffer tank during severe accidents. FSAR Tier 2, Section 9.2.7.2.2 will be revised to reflect this information.

4. The small seal pot shown on FSAR Tier 2, Figure 9.2.7-1, Sheet 2 will be removed. The details of the level instrumentation for the Safeguard Building 4 buffer tank (seal pot, fill line, and associated piping and components) and the FB buffer tank (sealed reference leg) will be removed to standardize level instrumentation design details for both buffer tanks. FSAR Tier 2, Figure 9.2.7-1, Sheet 2 will continue to show generic level instrumentation for the buffer tanks without providing specific details. Specific details of the level instrumentation will be identified later in the design process.

5. The details of the level instrumentation for the Safeguard Building 4 buffer tank (seal pot, fill line, and associated piping and components) and the FB buffer tank (sealed reference leg) will be removed to standardize level instrumentation design details for both buffer tanks. FSAR Tier 2, Figure 9.2.7-1, Sheet 2 will continue to show generic level instrumentation for the buffer tanks without providing specific details. Specific details of the level instrumentation will be identified later in the design process.

The staff reviewed the applicant’s March 20, 2009, response to RAI 163, Question 09.02.02-4, Part 1, and determined the response unacceptable, because the response changed the SEWSS function for the CVCS charging pumps from what appeared to be a backup source of seal water to the only source. Since the CVCS charging pumps may also operate in the post-accident period, in follow-up RAI 337, Question 09.02.02-80, the staff requested that the applicant revise the response and associated FSAR markups to further clarify that the SEWSS provides CVCS charging pump seal water during all conditions where the pumps can be in service including LOOP.

In a March 19, 2010, response to follow-up RAI 337, Question 09.02.02-80, Part 1, the applicant stated that the SEWSS pump is continuously running to fill the buffer tanks during normal plant operation and outages. During a loss of offsite power, the buffer tanks are not supplied by the seal water pump. An FSAR markup was provided which would add this information to FSAR Tier 2, Section 9.2.7.2.2.

The staff reviewed the applicant’s March 19, 2010, response to follow-up RAI 337, Question 09.02.02-80, Part 1, and finds it acceptable, because it clarifies the operation of the SEWSS pump during normal and abnormal operations and that during a LOOP, the buffer tanks are no longer being supplied by the SEWSS pump. The staff confirmed that Revision 2 of the FSAR, dated August 31, 2010, contains the changes committed to in the applicant’s responses to RAI 337, Question 09.02.02-80, Part 1. Accordingly, the staff finds the applicant has adequately addressed this issue providing clarification to the purpose of the buffer tanks. The buffer tanks provide a stored volume of seal water to the chemical and volume control system pump seals during normal plant operation and LOOP conditions, and to the severe accident heat removal system in the event of a severe accident. The staff considers RAI 163, Question 09.02.02-4, Part 1 and RAI 337, Question 09.02.02-80, Part 1 resolved.

The staff reviewed the applicant’s March 20, 2009, response to RAI 163, Question 09.02.02-4, Part 2, and determined the response unacceptable, because the safety valves that protect the buffer tanks from excessive nitrogen pressure are located in the nitrogen supply line and should be located at the buffer tanks for overpressure protection. Also, the safety valves are not shown on FSAR Tier 2, Figure 9.2.7-1, because they are outside of the seal water system boundary and are part of the central gas distribution system. However, the staff noted that the pressure relief devices have a valve between the relief valves and the ASME Boiler and Pressure Vessel (B&PV) that they protect; this is not an acceptable configuration. Consequently, in follow-up RAI 337, Question 09.02.02-80, Part 2, the staff requested that the applicant provide justification in the FSAR for the location of buffer tank relief protection that explains how this configuration complies with the design Codes referenced by FSAR Tier 2, Section 9.2.7 (ASME B&PV Code, Section VIII, Division 1-2004 and ANSI/ASME B31.1-2004) or provide adequate drawings of the nitrogen supply system and its interface with SEWSS.

In a March 19, 2010, response to follow-up RAI 337, Question 09.02.02-80, Part 2, the applicant stated that a relief valve is provided for each buffer tank. An FSAR markup was provided which would add this information to FSAR Tier 2, Section 9.2.7.2.2; FSAR Tier 2, Table 3.2.2-1; and FSAR Tier 2, Figure 9.2.7-1.

The staff reviewed the applicant's March 19, 2010, response to follow-up RAI 337, Question 09.02.02-80, Part 2, and determined it was partially acceptable, because it added safety relief protection for the buffer tanks and provided the necessary FSAR markups. However, the relief path for relief valves on the buffer tanks that contain nitrogen was not addressed and release of nitrogen could affect the occupants of the MCR or plant operators and prevent them from performing duties related to safe-shutdown. Therefore, in additional follow-up RAI 390, Question 09.02.02-106, Part c, the staff requested that the applicant address this item.

In an October 15, 2010, response to RAI 390, Question 09.02.02-106, Part c, the applicant stated that the vent path for the nitrogen gas from the buffer tanks for the SAHRS and CVCS vents to the safeguard building controlled area ventilation system and fuel building ventilation system, respectively. These systems filter the gases before exhausting the gas through the vent stack. The operation of this vent path affects neither the occupants in the MCR nor the plant operators performing duties related to safe-shutdown.

The staff reviewed the applicant's October 15, 2010, response to RAI 390, Question 09.02.02-106, Part c, and finds it acceptable, because there are no negative health effects to the MCR operators or operators performing activities related to safe-shutdown from the buffer tanks nitrogen discharge paths. The staff confirmed that Revision 2 of the FSAR, dated August 31, 2010, contains the changes committed to in the applicant's responses to RAI 337, Question 09.02.02-80, Part 2. Accordingly, the staff finds the applicant has adequately addressed this issue and, therefore, the staff considers RAI 337, Question 09.02.02-80, Part 2, and RAI 390, Question 09.02.02-106, Part c resolved.

The staff reviewed the applicant's March 20, 2009, response to RAI 163, Question 09.02.02-4, Part 3, and finds it acceptable, because the isolation valve on the outlet of the Safeguard Building 4 buffer tank, similar to the valve on the FB buffer tank was not needed. The severe accident pumps only run for mitigation of accidents beyond the normal design basis. The Safeguard Building 4 buffer tank isolation for maintenance can be achieved by isolation of the seal water supply to the buffer tank from the SEWSS solenoid valve. In contrast, a charging pump is continuously in service during normal operation and, therefore, local buffer tank isolation via the valve is provided. The staff finds this response and the associated proposed FSAR markup acceptable. The staff confirmed that Revision 1 of the FSAR, dated May 29, 2009, contains the changes committed to in the RAI response. Accordingly, the staff finds that the applicant has adequately addressed this issue and, therefore, the staff considers RAI 163, Question 09.02.02-4, Part 3 resolved.

The staff reviewed the applicant's March 20, 2009, responses to RAI 163, Question 09.02.02-4, Parts 4 and 5, and finds them acceptable, because the seal pots and associated bypass line for the severe accident buffer tank will be removed from FSAR Tier 2, Figure 9.2.7-1 and standard level instrumentation will be shown on the figure. The staff finds the response and the proposed markup of FSAR Tier 2, Figure 9.2.7-1, Sheet 2, eliminated the inconsistencies. The staff confirmed that Revision 1 of the FSAR, dated May 29, 2009, contains the changes committed to in the RAI response. Accordingly, the staff finds that the applicant has adequately addressed this issue since a more simplified approach was utilized to show the buffer tank level instrumentation and, therefore, the staff considers RAI 163, Question 09.02.02-4, Parts 4 and 5 resolved.

The staff noted that the only charging pump seal water supply shown on FSAR Tier 2, Figure 9.2.7-1 was connected downstream of the FB buffer tank solenoid isolation valve. However, the description in FSAR Tier 2, Section 9.2.7.3, "System Operation," for LOOP indicates that the charging pump supply from the buffer tank is normally locked closed. Since the buffer tanks are intended to provide seal water, in RAI 163, Question 09.02.02-5, with five subparts (shown below), the staff requested that the applicant identify the normal source of charging pump seal water, as well as answer several other questions related to the buffer tank capability.

1. Since the buffer tanks are intended to provide a backup supply of seal water and charging pumps are continuously in service during normal plant operation, describe the normal source and LOOP source of charging pump seal water in FSAR Tier 2, Section 9.2.7. This configuration should also be described in FSAR Tier 2, Section 9.3.4, "Chemical and Volume Control System (Including Boron Recovery System)," for the CVCS pump seal water.

2. FSAR Tier 2, Section 9.2.7.6, "Instrumentation Requirements," states seal water systems and components receive an "off" command on low seal water header pressure. It is not clear if this applies to all users including the CVCS pumps. Describe the basis for this feature and explain if this applies to the normal source of CVCS pump seal water (i.e., a CVCS pump is always in service during normal operation).

3. Describe in the FSAR the consequences if seal water is lost to a CVCS pump (pump seals fail, seal leakage, pump declared inoperable, etc.).

4. Describe in the FSAR the basis for the delay time to manually unlock the buffer tank (CVCS pump in an abnormal condition (e.g., LOOP)) and clarify this in the FSAR.

5. Describe in the FSAR the basis for the operating volume and nitrogen pressure for the buffer tanks.

In a March 20, 2009, response to RAI 163, Question 09.02.02-5, the applicant responded to each of these five items as follows:

1. The FB buffer tank supplies seal water to the CVCS charging pumps during plant operation and loss of offsite power. FSAR Tier 2, Sections 9.2.7.3.1 and 9.3.4 will be revised to reflect this clarification.

2. The seal water users in the radioactive waste processing building receive an "off" command on low water header pressure. The normal source of seal water to the CVCS is the FB buffer tank and the "off" command feature does not apply to the buffer tank CVCS supply. FSAR Tier 2, Section 9.2.7.6 will be revised to reflect that the seal water users in the radioactive waste processing building receive an "off" command on low seal water header pressure.

3. The CVCS pumps trip on loss of seal water supply. FSAR Tier 2, Section 9.3.4 will be revised to reflect this information.

4. The FB buffer tank isolation valves are open to supply the CVCS charging pumps during plant operation modes and LOOP, and there is no time delay to unlock the buffer tank isolation valve. FSAR Tier 2, Section 9.2.7.3.2 will be revised to reflect that the FB buffer tank isolation valves are normally open. The FSAR Tier 2, Section 9.2.7.3.2, "Abnormal Operation," statement that the CVCS pumps could be supplied by SEWSS during an anticipated transient without scram (ATWS) with LOOP will be removed, as this is not in the U.S. EPR design.

5. The buffer tank operating volume and nitrogen pressure will be based on the required supply to the CVCS pumps during LOOP and the severe accident heat removal system pumps during a severe accident. The operating volume and nitrogen pressure will be based on these systems operating for a specific length of time that will be determined later in the design process.

The staff reviewed the applicant's March 20, 2008, response to RAI 163, Question 09.02.02-5, Parts 1 and 3, and finds them acceptable, because clarification was made to FSAR Tier 2, Section 9.3.4.2.2, "Component Description," that the seal water to the CVCS during normal plant operations and during a LOOP is provided by the SEWSS. In addition, the CVCS pumps trip on loss of seal water supply. Reference is made in FSAR Tier 2, Section 9.3.4.2.2 to the SEWSS being described in FSAR Tier 2, Section 9.2.7. The staff confirmed that Revision 1 of the FSAR, dated May 29, 2009, contains the changes committed to in the RAI response. Accordingly, the staff finds that the applicant has adequately addressed this issue and, therefore, the staff considers RAI 163, Question 09.02.02-5, Parts 1 and 3 resolved.

The staff reviewed the applicant's March 20, 2009, response to RAI 163, Question 09.02.02-5, Part 2, and determined the applicant's response was partially acceptable. The response did provide a markup of FSAR Tier 2, Section 9.2.7.6 which stated the seal water users in the radioactive water processing building received an "off" command on low seal water header pressure and these changes have been incorporated into FSAR Tier 2, Revision 1. However, the response did not provide sufficient understanding of the "off" command. Therefore, in follow-up RAI 337, Question 09.02.02-81, Part 1, the staff requested that the applicant provide sufficient information in the FSAR response to permit an understanding of the differences for the pump trip function on loss of seal water between the CVCS pumps and radwaste users (e.g., identify different initiating signals). The staff also requested that the applicant revise the proposed FSAR markup to include information relative to the CVCS pump trip on loss of SEWSS in FSAR Tier 2, Sections 9.2.7.6 and 9.3.4.5, "Instrumentation Requirements."

In a March 19, 2010, response to follow-up RAI 337, Question 09.02.02-81, Part 1, the applicant stated that the CVCS pumps and SAHRS pumps trip because of a loss seal water supply only after there is low level of inventory in their respective buffer tank. Other seal water user's trip after a loss of onsite power and trip of the seal water supply system pumps. A proposed FSAR markup was provided for FSAR Tier 2, Sections 9.2.7.2.2 and 9.3.4.5.

The staff reviewed the applicant's March 29, 2010, response to follow-up RAI 337, Question 09.02.02-81, Part 1, and finds it acceptable, because clarification of the CVCS pumps and SAHRS pump trips were provided. Both the CVCS pumps and SAHRS pump trip because of a loss seal water supply only after there is low level of inventory in their respective buffer tanks. These pump trips for the CVCS and SAHRS are designed to prevent the spread of radioactively. The staff confirmed that Revision 2 of the FSAR, dated August 31, 2010, contains the changes committed to in the applicant's responses to RAI 337, Question 09.02.02-81, Part 1. Accordingly, the staff finds that the applicant has adequately addressed this issue and, therefore, the staff considers RAI 163, Question 09.02.02-5, Part 2, and RAI 337, Question 09.02.02-81, Part 1, resolved.

The staff reviewed the applicant's March 20, 2009, response to RAI 163, Question 09.02.02-5, Part 4, and finds it acceptable, because the applicant clarified that the FB buffer tank isolation valve is normally open rather than locked closed. In this configuration, the buffer tank will provide seal water to the CVCS charging pumps, which is necessary for normal operation. The staff confirmed that Revision 1 of the FSAR, dated May 29, 2009, contains the changes committed to in the RAI response. Accordingly, the staff finds that the applicant has adequately addressed this issue and, therefore, the staff considers RAI 163, Question 09.02.02-5, Part 4 resolved.

The staff reviewed the applicant's March 20, 2009, response to RAI 163, Question 09.02.02-5, Part 5, and determined the response unacceptable, because the requested information was not provided for the buffer volume and system pressures, as requested. Therefore, in follow-up RAI 337, Question 09.02.02-81, Part 2, the staff requested that the applicant address this issue.

In a March 19, 2010, response to follow-up RAI 337, Question 09.02.02-81, Part 2, the applicant stated that the design pressure of the buffer tanks is based upon 110 percent of the sum of the maximum pump discharge pressure and the pressure resulting from elevation differences between the pump and lowest seal water supply system user. The minimum volume of the buffer tank is 151.4 L (40 gal), and the design pressure is 1,620 kPa (235 psig).

The staff reviewed the applicant's March 19, 2010, response to follow-up RAI 337, Question 09.02.02-81, Part 2, and determined it partially acceptable, because the volume and the design pressure of the buffer tanks were provided. FSAR Tier 2, Table 9.2.7-1, "Seal Water Supply System Parameters," was added to the FSAR which states important SEWSS parameters such as flow rates, design pressure, and design temperature. However, the bases for the buffer tank sizing were not stated in the applicant's response; therefore, in follow-up RAI 390, Question 09.02.02-106, Part 5, the staff requested that the applicant provide this missing information.

In an October 15, 2010, response to RAI 390, Question 09.02.02-106, Part 5, the applicant provided the following:

> The sizing of the SEWSS buffer tanks is based on a straightforward calculation. The required volume is obtained by multiplying the required total flow rate by the required total duration of time for the availability of seal water at each user. The 40-gallon amount is based on the total required flow rate of 0.00264 gpm in the duration required of 250 hours for GHW45 BB001, while total required flow of 9.25E-5 gpm in the duration required of 7,000 hours for GHW 44 BB001. The total required flow rate and duration time values are based on a reference plant design. Since the buffer tanks are not safety-related tanks, this level of detail is not reflected in the FSAR.

The staff reviewed the applicant's October 15, 2010, response to RAI 390, Question 09.02.02-106, Part 5, and finds it acceptable, because the duration and flow rate provided in the applicant's response was found to be reasonable for a loss of power event with the SEWSS pumps off. For the CVCS buffer tanks, this would be 250 hours at 10 cc/min (3.8 gallons per day) and for the severe accident buffer tank this would be 7,000 hours at 0.35 cc/min (0.13 gallon per day). Therefore, the staff considers RAI 163, Question 09.02.02-5, Part 5; RAI 337, Question 09.02.02-81, Part 2; and RAI 390, Question 09.02.02-106, Part 5, resolved. Furthermore, the staff review identified several items in FSAR Tier 2, Section 9.2.7 that warranted additional explanation and clarification by the applicant. The staff used engineering judgment for the duration and flow rates noted above to determined acceptability of the buffer tanks. Therefore, in RAI 163, Question 09.02.02-6, with five subparts as shown below, the staff requested that the applicant:

1. Describe the initiating signals for the SEWSS pump automatic start described in FSAR Tier 2, Section 9.2.7.

2. Explain the presence of filters in the SEWSS flow path (FSAR Tier 2, Figure 9.2.7-1) for some components and not for others.

3. Justify the absence of differential pressure instrumentation (not shown on FSAR Tier 2, Figure 9.2.7-1).

4. The basis for the SEWSS pump trip on low demineralized water tank level needs to be explained.

5. The FSAR states that a reducing valve is provided to protect lower pressure downstream piping. Identify the piping this statement is referring to since it appears that all piping shown on FSAR Tier 2, Figure 9.2.7-1 has the same design pressure.

In a March 20, 2009, response to RAI 163, Question 09.02.02-6, the applicant stated:

1. Details about the initiating signal for the pump automatic start will be identified later in the design process.

2. The filter in the seal water supply system flow path in the Radioactive Waste Processing Building will be removed in FSAR Tier 2, Figure 9.2.7-1, Sheet 2.

3. Differential pressure instrumentation will be added to FSAR Tier 2, Figure 9.2.7-1, Sheet 1.

4. The basis for the shutdown of the seal water pumps (30GHW11/12 AP001) on the demineralized water storage tank low level signal is to protect the seal water pumps in the event of insufficient demineralized water supply. The low level setpoint for the tank will be determined later in the design process.

5. The SEWSS design pressure is based on the pump shut-off head plus the elevation differential to the system low point. The system areas in the Radioactive Waste Processing Building downstream of pressure reducing valves 30GHW46 AA003 and 30GHW46 AA011, have an operational pressure based on the users' component requirements. Users are protected against overpressure by safety relief valves 30GHW46 AA191 and 30GHW46 AA193 located downstream of the pressure-reducing valve. The safety relief valves release the expected maximum flow rate from fully

opened pressure-reducing valves. Specific operating pressure downstream of the pressure-reducing valves and the relief valve set points will be determined later in the design process.

The staff reviewed the applicant's March 20, 2009, response to RAI 163, Question 09.02.02-6, Part 1, and determined it unacceptable, because the requested information was not provided. Therefore, in follow-up RAI 337, Question 09.02.02-82, Part 1, the staff requested that the applicant provide the missing information.

In a March 19, 2010, response to follow-up RAI 337, Question 09.02.02-82, Part 1, the applicant stated that the when the entire SEWSS has been filled and vented, one seal water pump receives a "start" signal to deliver seal water flow at the required pressure. The second pump remains on "standby" and receives an automatic changeover "start" signal if the first pump fails to operate. A proposed FSAR markup was provided to add this information to FSAR Tier 2, Section 9.2.7.6.

The staff reviewed the applicant's March 19, 2010, response to follow-up RAI 337, Question 09.02.02-82, Part 1, and finds it acceptable, because it added the information related to the SEWSS pumps and automatic pump starts with addition information related to the standby configuration. The staff finds these design features for SEWSS pump starts and SEWSS standby configuration consistent with existing non-safety related similar systems. The staff confirmed that Revision 2 of the FSAR, dated August 31, 2010, contains the changes committed to in the applicant's responses to RAI 337, Question 09.02.02-82, Part 1. Accordingly, the staff finds that the applicant has adequately addressed this issue and, therefore, the staff considers RAI 163, Question 09.02.02-6, Part 1, and RAI 337, Question 09.02.02-82, Part 1 resolved.

The staff reviewed the applicant's March 20, 2009, response to RAI 163, Question 09.02.02-6, Part 2, and finds it acceptable because the filter in the SEWSS flow path in the radioactive water processing building was unnecessary to accomplish any safety function and was removed from FSAR Tier 2, Figure 9.2.7-1, Revision 1 and removed from FSAR Tier 2, Table 3.2.2-1, Revision 2. Therefore, the staff considers RAI 163, Question 09.02.02-6, Part 2, and RAI 337, Question 09.02.02-82, Part 2 resolved.

The staff reviewed the applicant's March 20, 2009, response to RAI 163, Question 09.02.02-6, Part 3, and finds it acceptable, because the differential pressure instrumentation was added to the buffer tanks on FSAR Tier 2, Figure 9.2.7-1, Revision 1. Therefore, the staff considers RAI 163, Question 09.02.02-6, Part 3, resolved.

The staff reviewed the applicant's response to RAI 163, Question 09.02.02-6, Part 4, and determined it partially acceptable. The staff determined the explanation adequate to permit an understanding of a pump protective feature in a non-safety-related system such as SEWSS. The bases of the seal water pump trip on demineralized water storage tank low water level was described; however, this information was not added to the FSAR. Therefore, in follow-up RAI 337, Question 09.02.02-82, Part 3, the staff requested that the applicant add the explanation with an appropriate technical justification (e.g., to maintain sufficient pump NPSH) to the description in FSAR Tier 2, Section 9.2.7.

In a March 19, 2010, response to follow-up RAI 337, Question 09.02.02-82, Part 3, the applicant stated that FSAR Tier 2, Section 9.2.7.6 would be revised (FSAR markup was provided) to add the appropriate technical justification to shut off the SEWSS pumps in case of low pressure (to maintain sufficient pump NPSH).

The staff reviewed the applicant's March 19, 2010, response to RAI 337, Question 09.02.02-82, Part 3, and finds it acceptable, because it clarifies that the pump protections features isolate the SEWSS pumps on sensed low pressure from the demineralized water storage tanks, thus providing SEWSS pump protection against insufficient pump NPSH. The staff confirmed that Revision 2 of the FSAR, dated August 31, 2010, contains the changes committed to in the applicant's responses to RAI 337, Question 09.02.02-82, Part 3. Accordingly, the staff finds that the applicant has adequately addressed this issue and, therefore, the staff considers RAI 163, Question 09.02.02-6, Part 4, and RAI 337, Question 09.02.02-82, Part 3, resolved.

The staff reviewed the applicant's March 20, 2009, response to RAI 163, Question 09.02.02-6, Part 5, and finds it acceptable, because pressure reducing and relief valves are provided to protect lower pressure components in the downstream piping of the radwaste area. Therefore, the staff considers RAI 163, Question 09.02.02-6, Part 5 resolved.

In summary, the staff considers RAI 163, Question 09.02.02-2; RAI 163, Question 09.02.02-4; RAI 163, Question 09.02.02-5; RAI 163, Question 09.02.02-6; RAI 337, Question 09.02.02-79; RAI 337, Question 09.02.02-80; RAI 337, Question 09.02.02-81; RAI 337, Question 09.02.02-82; and RAI 390, Question 09.02.02-106 resolved.

9.2.7.4.2 Technical Specifications

FSAR Tier 2, Chapter 16, "Technical Specifications" are not applicable to the U.S. EPR Seal Water Supply System.

9.2.7.4.3 ITAAC

There are no ITAAC applicable to the U.S. EPR Seal Water Supply System.

9.2.7.4.4 Initial Test Program

Prior to initial plant startup, a preoperational test is performed. FSAR Tier 2, Section 14.2, "Initial Plant Test Program," Test No. 045 is intended to demonstrate the ability of the SEWSS to provide seal water and demineralized water to selected plant systems and components as designed in FSAR Tier 2, Section 9.2.7. The seal water supply system is tested as described in FSAR Tier 2, Section 14.2, Test No. 045. The staff identified six items, as shown below, related to missing specific acceptance criteria and documented these in RAI 279, Question 14.2-126.

FSAR Tier 2, Section 14.2.12.5.3, Test No. 045, Acceptance Criteria 5.1.1 states that the "SEWSS pump and system flow meet design specification (refer to Section 9.2.7)"; however, no design specifications were provided in FSAR Tier 2, Section 9.2.7. Therefore, in RAI 279, Question 14.2-126, Part b, the staff requested that the applicant provide the design specifications for the SEWSS pump and system flow in FSAR Tier 2, Section 9.2.7.

In a September 23, 2009, response to RAI 279, Question 14.2-126, Part b, the applicant proposed adding FSAR Tier 2, Table 9.2.7-1, "Seal Water Supply System Parameters," which would add technical data on seal water supply system parameters including flow rates, system pressures and system temperatures, to the FSAR. The staff reviewed these changes and finds the changes acceptable, because the requested system parameters would be in FSAR Tier 2, Section 9.2.7 so that acceptance criteria in FSAR Tier 2, Section 14.2.12.5.3, Section 5.0 of the test can be confirmed. The staff confirmed that Revision 2 of the FSAR, dated August 31, 2010, contains the changes committed to in the applicant's responses to RAI 279, Question 14.2-126, Part b. Accordingly, the staff finds that the applicant has adequately addressed this issue and, therefore, considers RAI 279, Question 14.2-126, Part b, resolved.

FSAR Tier 2, Section 14.2.12.5.3, Test No. 045, Test Method Item 3.3 and Acceptance Criteria 5.1.4 states that the "SEWSS provides designed rated flow to systems that are supplied by the seal water header"; however, no flow rate specifications are provided in FSAR Tier 2, Section 9.2.7. Therefore, in RAI 279, Question 14.2-126, Part c, the staff requested that the applicant provide the design specifications for the SEWSS system flow rates to its supplied components in FSAR Tier 2, Section 9.2.7.

In an October 21, 2009, response to RAI 279, Question 14.2-126, Part c, the applicant proposed adding the seal water flow rate to FSAR Tier 2, Table 9.2.7-1. The staff determined that the specified system flow rate was reasonable at approximately 0.19 L/min (28.7 lb/h or 0.05 gpm). The staff confirmed that Revision 2 of the FSAR, dated August 31, 2010, contains the changes committed to in the applicant's responses to RAI 279, Question 14.2-126, Part c. Accordingly, the staff finds that the applicant has adequately addressed this issue and, therefore, the staff considers RAI 279, Question 14.2-126, Part c resolved.

FSAR Tier 2, Section 14.2.12.5.3, Test No. 045, Test Method Item 3.5, provides for confirmation that power-operated valves fail in the proper position; however, the failure position of the buffer tank supply solenoid valves is not identified in FSAR Tier 2, Section 9.2.7. Therefore, in RAI 279, Question 14.2-126, Part d, the staff requested that the applicant identify the failure position of the buffer tank supply valve upon a loss of operating power.

In an October 21, 2009, response to RAI 279 Question 14.2-126, Part d, the applicant indicated that the buffer tank supply valves fail closed on a loss of power. Also the applicant submitted a proposed FSAR markup of FSAR Tier 2, Section 9.2.7 supplying this information. The staff determined that the valves are designed to fail in a safe position of a loss of power event. Had the valves failed in the open position, the buffer tank would not have been able to maintain pressurized. The staff confirmed that Revision 2 of the FSAR, dated August 31, 2010, contains the changes committed to in the applicant's responses to RAI 279, Question 14.2-126, Part d. Accordingly, the staff finds that the applicant has adequately addressed this issue and, therefore, the staff considers RAI 279, Question 14.2-126, Part d resolved.

FSAR Tier 2, Section 14.2.12.5.3, Test No. 045, Test Method Item 3.7, provides for verification that the SEWSS can meet minimum and maximum design water pressure and temperature; however, the minimum and maximum design pressure and temperature are not identified in FSAR Tier 2, Section 9.2.7. Therefore, in RAI 279, Question 14.2-126, Part e, the staff requested that the applicant identify the SEWSS minimum and maximum design pressure and temperature in FSAR Tier 2, Section 9.2.7.

In a September 23, 2009, response to RAI 279, Question 14.2-126, Part e, the applicant proposed removing the term "minimum" from Section 3.7 of the test. The staff reviewed this change and finds it acceptable, because it removes the confusion of testing to 'minimum' design conditions. The staff finds that the SEWSS design pressure 1.62 megapascal (235 psig) and design temperature 60°C (140°F) is acceptable since it is similar to other non-safety related seal water system. The staff confirmed that Revision 2 of the FSAR, dated August 31, 2010, contains the changes committed to in the applicant's responses to RAI 279, Question 14.2-126, Part e. Accordingly, the staff finds that the applicant has adequately addressed this issue and, therefore, the staff considers RAI 279, Question 14.2-126, Part e resolved.

In RAI 279, Question 14.2-126, Part f, the staff requested that the applicant include a test method item that provides verification of the proper operation of the SEWSS buffer tank upon a LOOP.

Related to RAI 279, Question 14.2-126, Part f, in a September 4, 2009, response to RAI 260, Question 09.02.02-101, the applicant proposed adding Section 3.8 of the test which added proper operation of the seal water system buffer tank upon a simulated LOOP. The staff reviewed the change and finds the change acceptable, because the buffer tank will be tested under LOOP conditions. In a September 23, 2009, response to RAI 279, Question 14.2-126, the applicant referenced its response to RAI 260, Question 09.02.02-101. The staff confirmed that Revision 2 of the FSAR, dated August 31, 2010, contains the changes committed to in the applicant's responses to RAI 279, Question 14.2-126, Part f. Accordingly, the staff finds that the applicant has adequately addressed this issue and, therefore, the staff considers RAI 279, Question 14.2-126, Part f resolved.

In summary, as described above, the staff concluded that the testing proposed for the SEWSS is acceptable, therefore, the staff considers RAI 279, Question 14.2-126 resolved.

9.2.7.4.5 FSAR Discrepancies

In FSAR Tier 2, Section 9.2.7.2.1, "General Description," the applicant states that the discharge lines of the pumps combine into a common header which distributes the seal water to the various users in the Nuclear Auxiliary Building, Radioactive Waste Processing Building, Safeguard Buildings 1 and 4, and Fuel Building through piping, isolation valves, check valves, and buffer tanks. However, the staff's review of FSAR Tier 2, Figure 9.2.7-1 identified indication of system piping and components only in Safeguard Building 4 and not Safeguard Building 1. Therefore, in RAI 163, Question 09.02.02-3, the staff requested that the applicant address this issue. In a March 20, 2009, response to RAI 163, Question 09.02.02-3, the applicant confirmed that no SEWSS piping was present in Safeguard Building 1 and proposed a revision to FSAR Tier 2, Section 9.2.7 to remove the reference to this building. The staff finds the applicant's explanation and proposed FSAR revision constitutes an adequate response to RAI 163, Question 09.02.02-3. The staff confirmed that Revision 1 of the FSAR, dated May 29, 2009, contains the changes committed to in the RAI response. Accordingly, the staff finds that the applicant has adequately addressed this issue and, therefore, considers RAI 163, Question 09.02.02-3 resolved.

9.2.7.5 *Combined License Information Items*

There are no COL information items related to this area of review. The staff determined that no COL information items need to be included in FSAR Tier 2, Table 1.8-2, "U.S. EPR Combined License Information Items," for seal water supply system consideration.

9.2.7.6 *Conclusions*

The staff evaluated the SEWSS for the U.S. EPR standard plant design in accordance with the SRP guidance that is referred to in the above Regulatory Basis section, which includes NRC regulations GDC 2, GDC 60 and 10 CFR 20.1406.

Based on a review of the information that was provided and as discussed above in the Technical Evaluation, the staff concludes that the U.S. EPR SEWSS, as described under FSAR Tier 2, Section 9.2.7, Revision 2, is acceptable.

9.2.8 Safety Chilled Water System

9.2.8.1 *Introduction*

The SCWS supplies chilled water to the safety-related HVAC systems fuel building ventilation system (FBVS) and the LHSI pump seals and motors in Safeguard Buildings 1 and 4. The SCWS consists of four divisions, numbered 1 to 4. Division 1 and Division 2 are interconnected, and Division 3 and Division 4 are interconnected. Each division can remove 50 percent of the design-basis heat load. The SCWS rejects the heat via chiller refrigeration units, two of which are air cooled (Divisions 1 and 4) and two of which are water cooled (Divisions 2 and 3). The water cooled units are supplied with water from the CCWS, and the chillers are located in dedicated rooms within their respective Safeguard Building. Each chiller operates on environmentally safe refrigerants and contains a condenser, compressors, evaporator, and associated piping and controls.

9.2.8.2 *Summary of Application*

In a February 18, 2011, response to RAI 465, Question 09.02.01-51, the applicant provided. FSAR Interim Revision 3, which provided markups of the information provided in FSAR Revision 2 that is related to the SWCS. Therefore, the application as reviewed by the staff in this section consists of information provided in FSAR Revision 2, as supplemented by the markups provided by FSAR Interim Revision 3.

FSAR Tier 1: Specific design requirements of the SCWS are addressed in FSAR Tier 1, Interim Revision 3, Section 2.7.2, “Safety Chilled Water System.” The functional arrangement of the SCWS is shown in FSAR Tier 1, Figure 2.7.2-1, “Safety Chilled Water System Functional Arrangement.” Mechanical design information is provided in FSAR Tier 1, Table 2.7.2-1, “Safety Chilled Water System Equipment Mechanical Design,” which provides physical locations, function, ASME Code Section III applicability, and seismic category. Instrumentation and controls, electrical design information including power supplies, and display locations are identified in FSAR Tier 1, Table 2.7.2-2, “Safety Chilled Water System Equipment I&C and Electrical Design.” FSAR Tier 1, Table 2.7.2-3, “Safety Chilled Water System ITAAC,” lists the SCWS ITAAC.

FSAR Tier 2: The design basis and complete description of the SCWS are described in FSAR Tier 2, Interim Revision 3, Section 9.2.8, “Safety Chilled Water System,” and in Figure 9.2.8-1, “Safety Chilled Water System Diagram.”

ITAAC: ITAAC for the SCWS are included in FSAR Tier 1, Table 2.7.2-3.

Initial Test Program: Initial plant testing for the SCWS is described in FSAR Tier 2, Section 14.2.12.6.2, “Safety Chilled Water System (Test #052).”

Technical Specifications: The SCWS Technical Specifications associated with FSAR Tier 2, Section 9.2.8 are given in FSAR Tier 2, Chapter 16, “Technical Specifications,” TS 3.7.9, “Safety Chilled Water (SCW) System.”

9.2.8.3 *Regulatory Basis*

The relevant regulatory requirements for this area of review and the associated acceptance criteria are given for the most part in NUREG-0800, Section 9.2.2, “Reactor Auxiliary Cooling

Water System," Revision 4, and are summarized below. Review interfaces with other SRP sections can also be found in NUREG-0800, Section 9.2.2.

1. GDC 2, "Design Basis for Protection Against Natural Phenomena," as it relates to the capabilities of structures housing the system and the system itself having the capability to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, floods, tsunami, and seiches without loss of safety-related functions.

2. GDC 4, "Environmental and Dynamic Effects Design Bases," as it relates to effects of missiles inside and outside containment, effects of pipe whip, jets, environmental conditions from high- and moderate-energy line-breaks, and dynamic effects of flow instabilities and attendant loads (e.g., water hammer) during normal plant operation, as well as upset or accident conditions.

3. GDC 5, "Sharing of Structures, Systems, and Components," insofar as it requires that SSCs important to safety not be shared among nuclear power units unless it can be shown that sharing will not significantly impair their ability to perform their safety functions.

4. GDC 44, "Cooling Water," as it relates to the capability to transfer of heat from systems, structures, systems, and components important to safety to an ultimate heat sink during both normal and accident conditions, with suitable redundancy, assuming a single active component failure coincident with either the loss of offsite power or loss of onsite power.

5. GDC 45, "Inspection of Cooling Water System," as it relates to design provisions for inservice inspection of safety-related components and equipment.

6. GDC 46, "Testing of Cooling Water System," as it relates to design provisions for pressure and operational functional testing of cooling water systems and components in regard to

   - Structural integrity and system leak-tightness of its components
   - Operability and adequate performance of active system components
   - Capability of the integrated system to perform credited functions during normal, shutdown, and accident conditions

7. 10 CFR 52.47, "Contents of applications; technical information," Item (b)(1), which requires that a design certification application contain the proposed ITAAC that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a facility that incorporates the design certification has been constructed and will be operated in accordance with the design certification, the provisions of the Atomic Energy Act, and NRC regulations.

8. 10 CFR 20.1406, "Minimization of Contamination," as it relates to the standard plant design certifications and how the design and procedures for operation will minimize contamination of the facility and the environment facilitate eventual decommissioning and minimize to the extent practicable, the generation of radioactive waste.

Acceptance criteria adequate to meet the above requirements include:

- RG 1.29, "Seismic Design Classification," March 2007, (Seismic Design Criteria), Regulatory Position C.1 for safety-related and Regulatory Position C.2 for non-safety-related portions of the SCWS.

9.2.8.4 *Technical Evaluation*

The staff's evaluation of the SCWS is based upon the information provided in a February 18, 2011, response to RAI 465, Question 09.02.01-51. The RAI response transmitted markups to FSAR Revision 2 as FSAR Interim Revision 3, which included proposed changes to several FSAR Tier 2 sections, including FSAR Tier 2, Section 9.2.8

The staff requested that the applicant respond to questions in 40 RAIs that were based on the information in FSAR Tier 2, Revisions 0, 1, and 2 that described the design, operation, and testing of the SCWS. The applicant answered these questions in numerous responses that included FSAR markups which the staff has reviewed and finds acceptable because, in RAI 465 Question 09.02.01-51, the staff requested that the applicant compile and submit an FSAR markup that incorporated all the FSAR markups that were submitted separately as part of the responses to the 40 RAIs. In a February 19, 2011, response to RAI 465, Question 09.02.01-51, the applicant provided an Interim FSAR Revision 3 markup for the applicable sections.
The staff reviewed the FSAR Interim Revision 3 mark-up and confirmed that all of the SCWS RAI response markups had been successfully incorporated into it. In this report, the staff is not describing each staff RAI and the information the applicant provided in response to each RAI; rather, the staff's technical evaluation below is based on the staff's review of the interim FSAR Revision 3 markup for the applicable sections, which includes all the information submitted in response to the original 40 staff RAIs. In some cases, the staff may discuss the applicant's RAI responses where clarifying information which is not described in the FSAR to ensure that information is ultimately included in the FSAR, RAI 465, Question 09.02.01-51 is being tracked as a confirmatory item.

9.2.8.4.1 System Design Considerations

GDC 2

The staff reviewed the SCWS for compliance with the requirements of GDC 2 with respect to its design for protection against the effect of natural phenomena such as earthquakes, tornados, hurricanes, and floods. Compliance with the requirements of GDC 2 is based on meeting the guidance of RG 1.29, Regulatory Position C.1, for the safety-related portions of the system, and RG 1.29, Regulatory Position C.2 for non-safety-related portions of the system.

FSAR Tier 2, Section 3.2, "Classification of Structures, Systems and Components," categorizes SSCs based on safety importance and other considerations. FSAR Tier 2, Table 3.2.2-1, "Classification Summary," provides the component safety classifications, seismic classifications, quality group classifications, commercial codes, and locations of the SSCs. The staff finds that the safety classification, quality group, seismic category, and location for SCWS are properly designated. All safety-related portions of the SCWS, with the exception of the cross-tie piping between Divisions 1 and 2 and between Divisions 3 and 4, are located inside seismic Category I, tornado-, missile-, and flood-protected Safeguard Buildings. The SCWS cross-tie piping will be routed through the stair tower structures between Safeguard Building 1 and Safeguard Building 2, and between Safeguard Building 3 and Safeguard Building 4. The stair tower structures are Seismic Category I and designed to withstand the effects of earthquakes, tornadoes, hurricanes, floods, external missiles, and other natural phenomena.

In a May 20, 2009, response to RAI 174, Question 09.02.02-38, the applicant stated that the intake/ducting arrangement used to supply air to the air-cooled chiller units for Divisions 1 and 4 is a Seismic Category I tornado missile-protected part of the fully-hardened Safeguard Building structure. Air supply flows from intakes located on the sides of the Safeguard Buildings through the air-cooled condensers via a winding flow path before being discharged from the protected structure on the building roof making the hardened flow path Seismic Category 1. The air intake opening is equipped with an electrically heated rain/weather protection grille to prevent ice formation and has a fine wire mesh grille, which can be periodically cleaned to avoid the ingress of insects. The SCWS is Seismic Category 1 and ensures that failure of any non-safety-related portions of the system do not compromise any safety function of the SCWS. Based on its review of the above information and as discussed in Sections 3.4, 3.5, and 3.7 of this report and as provided below, the staff finds that the SCWS meets the relevant guidance of RG 1.29, Regulatory Positions C.1 and C.2, and the associated requirements of GDC 2.

Section 3.4 of this report addresses the staff's evaluation of flood protection provided for SSCs important to safety.

Section 3.5 of this report addresses the staff's evaluation of protection provided for SSCs important to safety from missiles.

FSAR Tier 2, Section 3.7.3.8.1, "Isolation of Non-Seismic Category I Subsystems," states that to avoid potential adverse interactions, non-seismic lines and associated equipment are routed outside of safety-related areas. In addition, FSAR Tier 2, Section 3.7.3.8, "Interaction of Other Systems with Seismic Category I Systems," identifies acceptable methods to address the potential for interaction between seismic and non-seismic items. Section 3.7 of this report further describes FSAR Tier 1 ITAAC to help verify that the non-safety-related SSCs will not adversely impact the function of safety-related SSCs during and after a safe-shutdown earthquake. The staff finds this acceptable to ensure that non-safety portions will not impact safety-related portions by either using separation of non-safety SSCs or using Seismic II Category SSCs in proximity to safety-related portions.

In summary and as discussed above, the staff finds that the non-safety and safety-related parts of the SCWS are properly classified such that the analyses, design features, and provisions described in FSAR Tier 2, Chapter 3, and evaluated by the staff in the corresponding sections of this report, will ensure that the SCWS is capable of performing its safety functions during the natural phenomena described in GDC 2. The design of these SSCs conforms to the guidance provided in RG 1.29 for meeting GDC 2 requirements. Therefore, the staff finds that the requirements of GDC 2 are met.

GDC 4

The staff reviewed the SCWS to determine if the design meets the relevant requirements of GDC 4 to remain functional during all postulated environmental conditions (or dynamic effects such as pipe breaks) associated with normal operations, maintenance, testing, and postulated accidents. Pipe diameters for the SCWS are based on limiting the flow velocity to 3.05 m/sec (10 ft/sec) for normal modes of operation that are expected to occur most often. The SCWS design temperature and pressure are such that the SCWS meets the staff definition of designate as a moderate-energy system. Section 3.6.1 of this report addresses the staff's evaluation of the design of structures, shields, and barriers necessary for SSCs to be protected against dynamic effects of high-energy and moderate-energy line breaks. Based on the staff's evaluation discussed in Section 3.6.1 of this report, the staff finds that the SCWS is protected against the effects of, and are compatible with the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents.

Compliance with GDC 4 is also based on meeting the actions requested in NRC GL 96-06, "Assurance of Equipment Operability and Containment Integrity during Design – Bases Accident Conditions and Water Hammer." As described in FSAR Tier 2, Section 9.2.8.3.1, the SCWS design minimizes the potential for dynamic flow instabilities and water hammer by avoiding high line velocities and has specified closing valve speeds that are slow enough to prevent damaging pressure increases. Vents are provided to vent and fully fill components and piping at high points in which voids could occur. The nitrogen pressurized expansion tank ensures system high points are retained at positive pressure. In addition to these design features, FSAR Tier 2, Section 14.2.12.6.2 includes testing to specifically address water hammer prevention during normal and emergency system evolutions. This includes, but is not limited to, valve realignments, pump starts/stops, and operation of valves that change position (e.g., cross-connects).

In summary, based on the preceding discussion, the staff concludes that the SCWS meets the requirements of GDC 4, including GL 96-06 and water hammer consideration for the SCWS. The SCWS is adequately protected from dynamic effects (including water hammer) due to equipment failures and external environmental conditions and is capable of performing its safety functions over the entire range of environmental conditions associated with normal operations, maintenance, testing, and postulated accidents in accordance with GDC 4 requirements.

GDC 5

The applicant must demonstrate that the sharing of SSCs between nuclear power units will not significantly impair the capability of the SCWS to perform its safety functions in accordance with GDC 5 requirements. The U.S. EPR standard plant design is a single-unit station, and consequently, there are no shared safety-related SSCs between different units. Therefore, the provisions of GDC 5 are not applicable to the U.S. EPR standard plant design.

GDC 44

As described in Section 9.2.8.1 of this report, the SCWS consists of four divisions numbered 1 to 4. Each division is located in one of the four Safeguard Buildings, providing each division physical separation from the other divisions (with the exception of the cross-tie piping described above). Each division has two cross-tie isolation valves (one supply and one return valve) located inside its respective Safeguard Building such that either division within a divisional pair could isolate its division by closing both of its associated cross-tie isolation valves. Each SCWS division is a closed loop system that supplies chilled cooling water to the HVAC cooling coils of the MCR, the electrical division rooms (SBVSE) in the Safeguard Buildings, safeguard building (controlled area) ventilation system (SBVS), FBVS, and the LHSI pump seal coolers and motor coolers in Safeguard Building Divisions 1 and 4. Each division consists of one refrigeration chiller unit, two pumps, one expansion tank, valves, user loads, and the associated piping and controls. Normally open, motor-operated, cross-tie valves interconnect the supply and return piping of Division 1 with Division 2, and the supply and return piping of Division 3 with Division 4. Each SCWS division chiller is sized to provide the maximum system cooling loads of two divisions. Each SCWS division pump is sized to provide the maximum flowrate and head of only one division. However, operating both pumps in a division provides the flowrate and head of two divisions. As a minimum, the pumps are designed to provide the corresponding design mass flow rate under the following conditions:

- Fluctuations in the supplied electrical frequency
- Increased pipe roughness due to aging and fouling
- Fouled debris filters
- Maximum pressure drop through the system heat exchangers
- Minimum water level in the expansion tank considers net positive suction head to prevent cavitation of the SCWS pump and to prevent vortex effects

During normal operation, at least one division of each divisional pair is in operation and supplies chilled water to both divisions in the divisional pair. The chiller and pumps in the idle divisions are placed in standby. The bounding system design parameters for all operating conditions are given in FSAR Tier 2, Table 9.2.8-1, “Safety Chilled Water Design Parameters for Cross-Tied Operation” and Table 9.2.8-2, “Safety Chilled Water Design Parameters Each Division Isolated.” The SCWS flow diagram is shown in FSAR Tier 2, Figure 9.2.8-1. The staff reviewed the SCWS description, tables, and figures to confirm that the flow paths and components have been identified and described in sufficient detail to enable a full understanding of the system design and operation. The staff compared the capacity of the SCWS to the heat loads of the systems the SCWS is credited with cooling and concluded that the flow rates and heat removal capability provided in the tables provided adequate cooling for SSCs important to safety during both normal and accident conditions. Also, because each of the safety-related SCWS divisions has its own safety-related emergency power source which is protected from the effects of natural phenomena as described in FSAR Tier 2, Chapter 3, and evaluated in the corresponding sections of this report, the loss of offsite power as a result of natural phenomena will not adversely affect the capability of the SCWS to perform its safety functions. Conversely, there is sufficient off site power for the SCWS to perform its safety function should on site power be unavailable.

In an October 15, 2010, response to RAI 361, Question 09.02.02-97, the applicant included an SCWS failure-modes-and-effects table (FSAR Table 9.2.8-4). The staff reviewed all potential single failures in the table to confirm that no single failure (assuming one division out for maintenance) would prevent the SCWS from performing its safety function, including during cross-connected operation. The SCWS design allows for isolating individual components such that removing a chiller or pump for maintenance in one division does not prevent the operating division from cooling its associated HVAC loads. The SCWS safety-related motor operated flow control valves and the motor operated cross-tie valves are powered from the normal 1E power division or alternately fed from the adjacent Class 1E power division. In cross-tie operation, the redundant power supplies allow operation of the SCWS flow control valves in two cross-tied divisions, including the ability to switch to the standby division in the divisional pair, or if necessary close the cross-tie valves. Division 2 is the alternate feed for Division 1 and vice versa. Division 4 is the alternate feed for Division 3 and vice versa. On an ECCS actuation the SCWS remains in normal operation, with one division in each operating divisional pair supplying both divisions. Only if a failure occurs in a SCWS division during the accident does an automatic division swapover occur. In the event of a DBA with LOOP, the previously operating chiller and pumps in the divisional pair will restart automatically after power is restored per the emergency sequence. If the previously operating division fails to restart after power is restored, the opposite stand-by division starts automatically within one minute. In the event that the cross-tie valves are closed with one pump running in each division prior to the DBA with LOOP, the second standby pump in the same division will automatically start within one minute if the previously running pump fails to start.

The staff reviewed all alarms, instrumentation, and control functions (including any credited operator actions) in FSAR Tier 2, Table 9.2.8-3, “Safety Chilled Water Instrumentation.” The SCWS system is controlled by the safety automation system (SAS) and the normal indication, manual control, and alarm functions are provided by the process information and control system (PICS). The staff verified that the instrument display location, and input to alarm and automatic or manual functions for instruments shown in FSAR Tier 2, Figure 9.2.8-1 are provided in FSAR Tier 2, Table 9.2.8-3. An automatic swapover to the standby division occurs if any of the following occurs:

1. A mechanical or electrical failure of a running SCWS pump
2. A mechanical or electrical failure of a running SCWS chiller
3. Chiller evaporator outlet temperature reaches the high-high setpoint for the running division
4. Chilled water flow through the evaporator reaches a MIN-2 set point for the running division

The automatic swapover process is discussed in detail in FSAR Tier 2, Section 9.2.8.6, “Instrumentation Requirements.” If the system experiences excessive leakage beyond system makeup capability, the cross-tie isolation MOVs are closed manually from the MCR on Low-2 system pressure. The idle standby division automatically starts on Low-2 pressure. The division without excessive leakage returns to pressure and the division with excessive leakage is manually stopped from the main control room. If the pressure falls to MIN-3, the following measures are initiated automatically for the affected division:

1. Chilled water system “Protection OFF” alarms. The MIN-3 system pressure setpoint trip occurs before the pressure corresponding to the minimum available NPSH is reached.
2. Refrigeration unit shuts down.
3. Chilled water circulating pump shuts down.

Each SCWS division contains a diaphragm expansion tank with a nitrogen fill connection in each of the Safeguard Buildings. The expansion tank accommodates changes in volume, creates SCWS pump NPSH, and establishes a point of reference pressure for the closed-loop system. These tanks, as well as the SCWS piping, have relief valve overpressure protection with setpoints in accordance with ASME B&PV Code, Section III, Class 3. The expansion tank pressure keeps the SCWS pump suction pressure well above the fluid vapor pressure to enhance available NPSH. The normal water volume in the expansion tank allows for volume displacement due to temperature changes and operating transitions. To prevent single failures from causing a complete loss of nitrogen or water volume in an expansion tank during cross-tied operation, procedures provide that the operators to close the cross-tie valves on MIN-2 pressure to isolate the failure and trip the SCWS operating pumps of the affected chiller division after reaching MIN-3 pressure.

The staff verified that the SCWS diaphragm expansion tank will contain a 7-day reserve volume of makeup water to account for normal SCWS leakage. The leakage rate for each cross-tie supply and return valve is 59 cm^3/hr (3.6 $in.^3$/hr) based on ASME QME-1. These are the only identified boundary valves for the system. The 7-day leakage volume also includes leakage of 0.375 L/hr (0.1 gal/hr) for valve stem packing, pump seal, tank diaphragm, and any remaining undefined leakage. Each SCWS expansion tank will include a minimum water volume of 378.5 L (100 gal) to accommodate potential system leakage of 1.89 L/hr (0.5 gal/hr) for 24 hrs for 7 days continuous with no makeup source in post-seismic conditions. The 378.5 L (100 gal) minimum volume allows for sufficient makeup water margin. FSAR Tier 2, Table 3.9.6-2, "Inservice Valve Testing Program Requirements," includes the cross-tie isolation valves to ensure the boundary leakage assumptions remain valid over the life of the plant. In cross-tie operation, the expansion tank in the standby division in a divisional pair is not isolated from the system. The staff considered potential sluicing of water between two expansion tanks during cross-tied operation as system loads cycle on or chillers trip and start the standby unit. The staff determined that sluicing is precluded in the design due to the dampening effect of the diaphragm and the compressed nitrogen, resistance of the long length of piping between tanks, and resistance of the small diameter piping at the tank connection. Each SCWS expansion tank will maintain a defense in depth post-seismic emergency manual makeup spool piece connection to a Seismic Category II makeup water source. This post-7-day water supply from the Seismic Category II fire water distribution system inside the Nuclear Island will serve as a non-safety-related back-up water source to the safety-related, 378.5 L (100 gal) expansion tank. The seismic makeup connection is shown on FSAR Tier 2, Figure 9.2.8-1. The fire water distribution system is designed to remain functional after an SSE as described in FSAR Tier 2, Section 9.5.1.2.1, "General Description." Under seismic or post-accident conditions, when demineralized water may be unavailable for SCWS makeup, a manual connection to the fire water distribution system is available to provide a seismic makeup source within a time frame consistent with the SCWS expansion tank capacity to accommodate expected out-leakage from the system for 7 days.

Freeze protection for the evaporator coils is provided by installing a chiller bypass valve in each SCWS division to regulate the amount of SCWS flow that goes back through the chiller. Liquid filters are installed upstream of the modulating flow control valves to protect throttling surfaces from minor corrosion debris, or debris from maintenance activities. A differential pressure limit across the filter, to allow for 30 days of operation post DBA, is maintained by normal maintenance.

The staff finds that the SCWS has the heat removal capacity to transfer the DBA heat load to the safety-related chillers from SSCs important to safety and the required redundancy to address single failure scenarios. In addition, the SCWS has sufficient emergency power supplies, freeze protection, chemistry controls, and NPSH margin for the SCWS pump. The SCWS expansion tank sizing ensures a 7-day seismically qualified volume of makeup water for each division under accident conditions. On the basis of the above discussion, the staff finds that the SCWS complies with the requirements of GDC 44 for providing cooling water to the safety-related HVAC systems, the FBVS, and the LHSI pump seals and motors (in Divisions 1 and 4).

GDC 45

FSAR Tier 2, Section 9.2.8.1, "Design Bases," states that the SCWS is designed to permit appropriate periodic inspection of important components to provide assurance of the integrity and capability of the system in accordance with GDC 45. Similarly, FSAR Tier 2, Section 9.2.8.5, “Inspection and Testing Requirements,” states that the installation and design of the SCWS provides accessibility for the performance of periodic testing and inservice inspection with limited personnel exposure.

Based on the fact that all portions of the SCWS are accessible in the safeguards building, the staff finds that sufficient provisions have been established to conclude that reasonable assurance of compliance with GDC 45 exists.

GDC 46

Normally, two divisions of SCWS operate continuously (in cross-tied configuration) during all plant operating modes. Operation of the pumps and chillers is rotated in service on scheduled basis to obtain even wear, or they are periodically tested in accordance with plant technical specifications. Because the system is designed such that these TS surveillances can be accomplished, the staff concludes that the requirements of GDC 46 are satisfied.

10 CFR 20.1406, “Minimization of Contamination”

10 CFR 20.1406 requires that applicants for standard plant design certifications describe how the facility design and procedures for operation will minimize, to the extent practicable, contamination of the facility and the environment, as well as the generation of radioactive waste.

The SCWS is an intermediate closed loop cooling water system that removes heat from safety-related equipment during normal operating, accident, and shutdown conditions. Because it is a closed loop system, there is no direct path for release of radioactive material from the SCWS to the environment. A process radiation monitor is provided in Divisions 1 and 4 of the SCWS, downstream of the LHSI pump mechanical seal heat exchanger cooler to monitor for possible leakage of radioactive fluid from the heat exchanger and isolate the division if warranted. FSAR Tier 2, Sections 11.5.4.7 and 11.5.4.18 describe the operational characteristics of the SCWS radiation monitoring systems and sampling provision and FSAR Tier 2, 12.3.6.5.9 describes the approach used in designing systems to minimize the cros-contamination of non-radioactive systems and prevent unmonitored and uncontrolled releases of radioactivity in the environment. In addition, any unexpected increase in SCWS surge tank level also provides indication of a leak into the SCWS. Besides the LHSI pump mechanical seal heat exchanger cooler in Divisions 1 and 4, migration of radioactive material from potentially radioactive systems is prevented by a minimum of two heat exchanger barriers, so no additional radiation monitors are needed in the SCWS. For example, radiation monitors are in the CCWS to detect radioactive contamination entering and exiting the system such that detection and isolation would occur prior to potentially contaminating the SCWS. The staff’s evaluation of the design features of the associated radiation monitoring system and sampling provisions are presented in Sections 11.5 and 12.3.6 of this report. Therefore, the staff concludes that the SCWS design as described in the FSAR complies with the requirements of 10 CFR 20.1406 and NRC guidance.

9.2.8.4.2 Technical Specifications

TS 3.7.9 provide LCO and SRs for the SCWS. TS 3.7.9 requires entry into a 30-day LCO if one of the SCWS safety divisions is inoperable.

TS SR 3.7.9.4 requires periodic (24 mo) verification that leakage for each SCWS division is less than 1.89 L/hr (0.5 gal/hr). If leakage is above this limit, that SCWS division will be declared inoperable if the associated division is not already out of service. This requirement is to ensure that the 7-day expansion tank makeup water volume assumption remains valid. The fact that the SCWS normally operates with its only system boundary valves (e.g., the divisional cross-tie valves) open during all modes of operation allows for longer times between required surveillances.

Chapter 16 of this report includes the staff's evaluation of the SCWS to assure that the proposed LCO and associated Bases adequately address and reflect system-specific design considerations as described in FSAR Tier 2, Section 9.2.8.

9.2.8.4.3 ITAAC

FSAR Tier 1, Section 2.7.2, "Safety Chilled Water System," provides U.S. EPR design certification information and ITAAC for the SCWS. FSAR Tier 1 information for balance-of-plant SSCs is evaluated in Section 14.3.7 of this report, and evaluation of FSAR Tier 1 information in this section is an extension of the evaluation provided in Section 14.3.7. This evaluation pertains to plant systems aspects of the proposed FSAR Tier 1 information for SCWS.

The staff reviewed the descriptive information, safety-related functions, arrangement, mechanical, I&C and electric power design features, environmental qualification, as well as system and equipment performance requirements provided in FSAR Tier 1, Section 2.7.2 to confirm completeness and consistency with the plant design basis as described in FSAR Tier 2, Section 9.2.8. The staff also reviewed FSAR Tier 1, Table 2.7.2-1, Table 2.7.2-2, Table 2.7.2-3, and Figure 2.7.2-1.

The staff finds that all the necessary SCWS equipment has been adequately identified in the applicable tables. Therefore, the staff concludes that the SCWS and their supporting systems comply with the requirements of 10 CFR 52.47(b)(1).

9.2.8.4.4 Initial Test Program

Applicants for combined licenses must provide plans for pre-operational testing and initial operations in accordance with 10 CFR 52.79(a)(28), "Contents of applications; technical information," requirements. FSAR Tier 2, Section 14.2.12.6.2 (Test #052), describes the initial test program for the SCWS.

Section 14.2 of this report addresses the staff's evaluation of the initial test program for U.S. EPR SCWS.

9.2.8.5 *Combined License Information Items*

There are no COL information items related to this area of review. The staff determined that no COL information items need to be included in FSAR Tier 2, Table 1.8-2, "U.S. EPR Combined License Information Items," for safety chilled water system consideration.

9.2.8.6 *Conclusions*

The staff evaluated the SCWS for the U.S. EPR standard plant design in accordance with the guidance that is referred to in Section 9.2.8.3, "Regulatory Basis" of this report. The staff's review included information in the FSAR as supplemented by the applicant's response to numerous RAIs which have been incorporated in FSAR Interim Revision 3 and used for this report.

The staff finds that the applicant appropriately identified minimum SCWS heat load and flow capabilities for individual safety-related components, as well as for the system as a whole in various relevant modes of operation. The staff finds that the U.S. EPR four safety-related division design with a minimum of two divisions required, provides inherent tolerance to single failures.

The staff review also included the SCWS ITAAC, pre-operational testing and technical specifications and finds these sections provided reasonable assurance that the SCWS will be inspected, tested, and operated in accordance with the SCWS design basis.

Except for RAI 465, Question 09.02.01-51, which is being tracked as a confirmatory items, and based on the review summarized above, the staff concludes that the SCWS design complies with the guidance of NUREG-0800, Section 9.2.2, and that the information provided by the applicant as described in this report adequately demonstrates that the requirements of 10 CFR Part 50, Appendix A, "General Design Criteria for Nuclear Power Plants," GDC 2, GDC 4, GDC 44, GDC 45, GDC 46, and 10 CFR 20.1406 are met. In addition, the staff concludes that if the ITAAC for SCWS are performed and the acceptance criteria met, there is reasonable assurance the design certification is built and will operate in accordance with the design certification, the provision of the Atomic Energy Act of 1954, and NRC regulations which include 10 CFR 52.47(b)(1).

9.2.9 Raw Water Supply System

9.2.9.1 *Introduction*

The initial source of water supplied to the plant demineralized water, potable and sanitary water, essential service water, and fire protection systems is provided by the raw water supply system (RWSS). Because this system is site-specific, it is not included within the scope of the design certification. However, conceptual design information (CDI) for this system is provided in FSAR Tier 2, Section 9.2.9, "Raw Water Supply System," to assist in identifying system interface requirements that must be implemented by COL applicants.

9.2.9.2 *Summary of Application*

FSAR Tier 1: There are no FSAR Tier 1 entries for this area of review.

FSAR Tier 2: The applicant has provided an FSAR Tier 2 system description in Section 9.2.9, "Raw Water Supply System," summarized here, in part, as follows:

The raw water supply system is a non-safety-related system that is site-specific and will be addressed by each applicant as a COL item. The RWSS takes water from a naturally occurring source, processes it as needed, and uses it to resupply other systems during normal operation. The RWSS is isolated on a DBA initiation signal.

ITAAC: There are no ITAAC items for this area of review.

Technical Specification: There are no Technical Specifications for this area of review.

Combined License Information Items:

COL Information Item No. 9.2-3 states:

The raw water supply system (RWSS) and the design bases of the RWSS are site-specific and will be addressed by the COL applicant.

9.2.9.3 *Regulatory Basis*

The relevant requirements of NRC regulations for this area of review, and the associated acceptance criteria, are given in 10 CFR 52.47, “Contents of application; technical information”:

1. 10 CFR 52.47(a)(24), Contents of applications: technical information, requires the inclusion of a representative conceptual design for those portions of the plant that are not included within the scope of the certified design.

2. 10 CFR 52.47(a)(25), requires the identification of interface requirements that must be met by those portions of the plant that are not included within the scope of the certified design.

NUREG-0800, Sections 9.2.1, “Station Service Water System,” and 9.2.5, “Ultimate Heat Sink,” provides guidance on related systems (station service water system and ultimate heat sink). However, since the RWSS is CDI, this review is deferred to the COL.

9.2.9.4 *Technical Evaluation*

The staff reviewed the RWSS based upon the information provided in FSAR Tier 2, Section 9.2.9, and the regulatory requirements provided in 10 CFR 52.47(a)(24) and (25).

As stated in FSAR Tier 2, Section 9.2.9, the design of the RWSS is site-specific, and will be addressed by the COL applicant The staff is concerned that a conceptual design including interface requirements was not provided as required by 10 CFR 52.47(a)(24), which states that, a design certification applicant should submit as part of its application, “A representative conceptual design for those portions of the plant for which the application does not seek certification, to aid the staff in its review of the FSAR and to permit assessment of the adequacy of the interface requirements in Paragraph (a)(25) of this section.” In RAI 169, Question 09.05.02-2, RAI 397, Question 09.02.05-21, and RAI 397, Question 09.02.05-36, the staff requested that the applicant establish the conceptual design, interface requirements, and define safety-related functions.

In a February 23, 2009, response to RAI 169, Question 9.2.5-2, a March 11, 2010, response to RAI 277, Question 9.2.5-21, and a September 22, 2010, response to RAI 397 Question 9.2.5-36, the applicant updated FSAR Tier 2, Section 9.2.9, “Raw Water Supply System.” In Revision 2 of the application the applicant provided a conceptual design drawing, Figure 9.2.9-1, “Conceptual Site-Specific Raw Water System,” and stated that there are no safety-related functions associated with the raw water supply systems and that all interfaces with the safety-related ultimate heat sink are controlled by safety-related motor operated valves that close on an accident initiation signal. In a September 22, 2010, response to RAI 397, Question 09.02.05-36, the applicant clarified the interface design and provided an interim markup to FSAR Tier 2, Section 9.2.9, “Raw Water Supply System” in Revision 3 which will be verified for incorporation. In a September 22, 2010, response to RAI 397, Question 09.02-05-36, the applicant further identified that the certified portion of the normal makeup water system is described in FSAR Tier 2, Section 9.2.5. **RAI 397, Question 09.02.05-36 is being tracked as a confirmatory item**.

FSAR Tier 1, Section 4.7, "Essential Service Water System and Ultimate Heat sink," describes the emergency makeup water system for the ESWS. The evaluation of the emergency makeup water system for the ESWS is addressed in Section 9.2.5 of this report.

9.2.9.5 *Combined License Information Items*

The RWSS and the design requirements of the RWSS are site-specific and will be addressed by the COL applicant.

Table 9.2.9-1 U.S. EPR Combined License Information Items

Item No.	Description	FSAR Tier 2 Section
9.2-3	The raw water supply system (RWSS) and the design requirements of the RWSS are site-specific and will be addressed by the COL applicant.	9.2.9

The staff finds the above listing to be complete. Also, the list adequately describes actions necessary for the COL applicant. No additional COL information items need to be included in FSAR Tier 2, Table 1.8-2 for RWSS consideration.

9.2.9.6 *Conclusions*

The staff evaluated the RWSS for the U.S. EPR standard plant design in accordance with the guidance that is referred to in Section 9.2.9.3 of this report. Based upon a review of the information that was provided and as discussed above in the Technical Evaluation, section the staff finds that the RWSS conceptual design is adequate to allow the staff to assess the adequacy of the interface requirements.

In summary, the staff concludes that the RWSS is CDI and non-safety-related and performs no safety function. The requirements of 10 CFR 52.47 have been satisfied and the staff concludes that there are no Tier 1 interface requirements that need to be included in the U.S. EPR application

9.2.10 Turbine Building Closed Cooling Water System

9.2.10.1 *Introduction*

The turbine building closed cooling water system (TBCCWS) is a non-safety-related closed loop system that provides water to non-safety-related secondary side conventional island (CI) equipment coolers and heat exchangers (HXs). The TBCCWS removes heat generated by components in the conventional part of the plant and transfers it to the non-safety-related auxiliary cooling water system (ACWS) for rejection to the normal heat sink.

9.2.10.2 *Summary of Application*

FSAR Tier 1: There are no Tier 1 entries for this area of review.

FSAR Tier 2: The applicant has provided a system description in FSAR Tier 2, Section 10.2.2.4, "Excitation System," provided here in part, as follows:

The turbine building closed cooling water system provides cooling water to the turbine generator brushgear air-to-water heat exchangers.

ITAAC: There are no ITAAC items for this area of review.

Technical Specifications: There are no technical specifications for this area of review.

9.2.10.3 *Regulatory Basis*

The relevant requirements of NRC regulations for this area of review, and the associated acceptance criteria, are not specified in NUREG-0800. While not directly applicable to the TBCCWS, the staff used SRP Section 9.2.1, "Station Service Water System," Revision 5, March 2007; SRP Section 9.2.2, "Reactor Auxiliary Cooling Water System," Revision 4, March 2007; and SRP Section 10.4.3, "Turbine Gland Sealing System," Revision 3 March 2007, as guidance for evaluating the adequacy of the TGCCWS.

The acceptance criteria contained in the noted SRP sections which are of importance related to the TBCCWS include:

1. GDC 2, "Design Basis for Protection Against Natural Phenomena," as it relates to the capabilities of structures housing the system and the system itself having the capability to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, floods, tsunami, and seiches without loss of safety-related functions

2. GDC 60, "Control of Releases of Radioactive Materials to the Environment," as it relates to the control of releases of radioactive materials to the environment. As part of GDC 60 acceptance criteria, 10 CFR 20.1406, "Minimization of Contamination," will also be considered.

9.2.10.4 *Technical Evaluation*

The staff determined that the TBCCWS was not adequately described in FSAR Tier 2, Revision 0, Revision 1, or Revision 2. Therefore, in RAI 375, Question 09.02.02-105, the staff requested that the applicant either provide a full description of the TBCCWS in FSAR Tier 2, Chapters 9 and 10, or revise FSAR Tier 2, Section 1.8, "Interfaces with Standard Designs and Early Site Permits," to indicate that the TBCCWS is outside the scope of the U.S. EPR standard design and provide a conceptual design of the TBCCWS and the TBCCWS heat sink. In a September 9, 2010, response to RAI 375, Question 09.02.02-105, the applicant proposed adding the missing TBCCWS information into a new FSAR Tier 2, Section 9.2.10, "Turbine Building Closed Cooling Water System."

In the September 9, 2010, response to RAI 375, Question 09.02.02-105, the applicant also proposed adding a new FSAR Tier 1, Section 2.7.13, "Turbine Building Closed Cooling Water System," but did not propose any Tier 1 information or ITAAC for the TBCCWS.

The TBCCWS performs no safety-related functions and is classified non-safety-related and non-seismic. The system is not important to safety and is not required to operate during or after a design-basis earthquake (DBE). The failure of the non-seismic TBCCWS (including the effects of jet impingement and flooding) will not lead to the failure of any safety-related systems, structures, and components. Initial plant testing of the TBCCWS will be in accordance with conventional good operating practices and component supplier/manufacturer recommendations. Flooding of the Turbine Building due to failure of the TBCCWS is bounded by the failure of the site-specific circulating water system. The TBCCWS has no connection to systems having the potential for containing radioactive materials. The TBCCWS is designed for a single unit and is not shared with other units.

The TBCCWS provides cooling to several secondary side CI power generation components. The system has adequate margin in its heat removal capacity to accommodate the highest user heat loads with the maximum expected cooling water temperature in the ACWS.

The staff's evaluation of TBCCWS is based upon the information provided by the applicant in its September 9, 2010, response to RAI 375, Question 09.02.02-105. The following FSAR sections which address additional aspects of the U.S. EPR TBCCWS have also been reviewed by the staff for compliance with regulatory requirements:

- Tier 1, Section 2.7.13 (new section)
- Tier 2, Table 1.1-1, "U.S. EPR FSAR Acronyms and Descriptions"
- Tier 2, Table 3.2.2-1, "Classification Summary"
- Tier 2, Section 9.2.10 (new section)
- Tier 2, Section 10.2.2.4
- Tier 2, Section 10.4.2.2.1, "General Description"

In RAI 375, Question 09.02.02-105, the staff requested that the applicant either provide a full description of the TBCCWS in FSAR Chapters 9 and 10 or revise FSAR Tier 2, Section 1.8 to indicate that the TBCCWS is outside the scope of the U.S. EPR standard design and provide a conceptual design of the TBCCWS and the TBCCWS heat sink in FSAR Tier 2, Chapter 9. Additionally, the staff requested that the applicant fully address those portions of SRP Section 9.2.2, which pertain to the non-safety cooling water systems. The staff indicated that GDC 2 and 10 CFR 20.1406, and ITAAC requirements should be discussed as applicable including interface requirements for conceptual design portions.

In a September 9, 2010, response to RAI 375, Question 09.02.02-105, the applicant proposed adding FSAR Tier 2, Sections 9.2.10, 9.2.10.1, "Design Bases"; 9.2.10.2.1, "System Description"; 9.2.10.2.2, "Component Description," 9.2.10.3, "System Operation"; 9.2.10.4, "Safety Evaluation"; 9.2.10.5, "Inspection and Testing Requirements"; 9.2.10.6, "Instrumentation Requirements"; and FSAR Tier 1, Section 2.7.13, and proposed revising FSAR Tier 2, Table 1.1-1; FSAR Tier 2, Table 3.2.2-1; FSAR Tier 2, Section 10.2.2.4; and FSAR Tier 2, Section 10.4.2.2.1.

9.2.10.4.1 System Design Considerations

GDC 4, "Environmental and Dynamic Effects Design Bases"; GDC 5, "Sharing of Structures, Systems and Components"; GDC 44, "Cooling Water"; GDC 45, "Inspection of Cooling Water Systems"; and GDC 46;"Testing of Cooling Water Systems."

In a September 9, 2010, response to RAI 375, Question 09.02.02-105 for GDC 4, GDC 5, GDC 44, GDC 45, and GDC 46, the applicant adding the following to FSAR Tier 2, Section 9.2.10.4:

> The TBCCWS does not perform any safety function and it does not interface with any safety-related system. The system is not important to safety and is not required to operate during or after a DBE. Therefore, the requirements of GDC 4, 44, 45, and 46 do not apply.
>
> The TBCCWS is designed for a single unit and is not shared with other units.

The staff reviewed the proposed FSAR addition of Section 9.2.10 and concluded that GDC 4, GDC 5, GDC 44, GDC 45, and GDC 46 are not applicable to the design. The staff considers this issue resolved, since the TBCCWS is not important to safety, does not perform any safety function, does not interface with any safety-related system, is not required to operate during or after a DBE, is designed for a single unit, and is not shared with other units.

<u>GDC 2</u>

GDC 2 requires SSCs important to safety to be protected from natural phenomena such as seismic events. In a September 9, 2010, response to RAI 375, Question 09.02.02-105 for GDC 2, the applicant added the following to FSAR Tier 2, Section 9.2.10.4:

> The TBCCWS does not perform any safety function and it does not interface with any safety-related system. The system is not important to safety and is not required to operate during or after a DBE.
>
> The TBCCWS complies with GDC 2 by adhering to the guidance of Regulatory Position C.2 of RG 1.29 for confirming that failures of the TBCCWS during seismic events will not affect the performance of any safety-related systems or components. The TBCCWS equipment is located entirely within the TB. Cooling loads are primarily in the TB. As required, cooling loads in non-safety-related outdoor areas and in the electric switchgear building may be served. No safety-related equipment is located in the turbine building or in non-safety-related outdoor areas. Since the system is physically separated from the Nuclear Island (NI) by multiple structural barriers, a malfunction of the TBCCWS does not adversely affect the safe-shutdown of the plant or impact the performance of any required safety function. Therefore, the failure of the non-seismic TBCCWS (including the effects of jet impingement and flooding) cannot lead to the failure of any safety-related systems, structures and components. Flooding of the TB due to failure of the TBCCWS is bounded by the failure of the site specific circulating water system (CWS) which is referred in U.S. EPR Combined License Information Item No. 10.4-5.

The staff reviewed the proposed addition of FSAR Tier 2, Section 9.2.10.4 and concluded that the TBCCWS is seismically classified as non-seismic (NSC). The staff considers this issue resolved, since the TBCCWS is not important to safety, does not perform any safety function, does not interface with any safety-related system, and is not required to operate during or after a DBE. Also, flooding of the Turbine Building (TB) due to failure of the TBCCWS is bounded by the failure of the site-specific circulating water system.

In summary, the staff concludes that the TBCCWS complies with GDC 2 since the guidance of Regulatory Position C.2 of RG 1.29 is met and that failures of the TBCCWS during seismic events will not affect the performance of any safety-related systems or components.

GDC 60 and 10 CFR 20.1406

In a September 9, 2010, response to RAI 375, Question 09.02.02-105 for GDC 60, the applicant added the following to FSAR Tier 2, Section 9.2.10.4:

> The TBCCWS has no connection to systems having the potential for containing radioactive materials.

The staff reviewed the proposed addition of FSAR Tier 2, Section 9.2.10.4 and concluded that GDC 60 is not applicable to this design and considers this issue resolved, since the TBCCWS has no connection to systems having the potential for containing radioactive materials. In addition, the requirements of 10 CFR 20.1406 are not applicable since the TBCCWS has no connection to systems having the potential for containing radioactive materials. Finally, the turbine building drain system is equipped with a radiation monitoring system and includes sampling provision should radioactivity be present in turbine system drains and detected by the monitor. FSAR Tier 2, Section 11.5.4.15 describes the operational characteristics of the radiation monitoring system installed on the turbine building common drain line. Additionally, FSAR Tier 2, Section 11.5.4.15 describes the approach used in designing systems to minimize the cross-contamination of non-radioactive systems and prevent unmonitored and uncontrolled releases of radioactivity in the environment. The staff's evaluation of the design features of the associated radiation monitoring system and sampling provisions are presented in Sections 11.5 and 12.3.6 of this report. In summary, the staff finds that the applicant's September 9, 2010, response to RAI 375, Question 09.02.02-105 adequately addresses the applicable GDC 60 and 10 CFR 20.1406.

RAI 375, Question 09.02.02-105 is being tracked as a confirmatory item to ensure that the FSAR is revised accordingly.

9.2.10.4.2 Technical Specifications

FSAR Tier 2, Chapter 16, "Technical Specifications" are not applicable to the TBCCWS.

9.2.10.4.3 Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC)

ITAAC are not applicable to the TBCCWS.

9.2.10.4.4 Initial Test Program

In a September 9, 2010, response to RAI 375, Question 09.02.02-105 for test programs, the applicant added the following to FSAR Tier 2, Section 9.2.10.5:

> System components are designed to permit appropriate pre-service and startup testing in conformance with conventional good operating practices and component supplier recommendations. The pressure relief valves will be tested and maintained in accordance with the manufacturer's recommendation.

The staff reviewed the proposed addition of FSAR Tier 2, Section 9.2.10.5 and finds the initial test program described above acceptable. The staff considers this issue resolved, since the TBCCWS is classified as non-safety-related and, therefore, considered a commercial grade system where using conventional good practices and component supplier/manufacturer recommendations is acceptable.

9.2.10.5 *Combined License Information Items*

There are no COL information items related to this section. No COL information items need to be included in FSAR Tier 2, Table 1.8-2 for TBCCWS consideration.

9.2.10.6 *Conclusions*

The staff evaluated the TBCCWS for the U.S. EPR standard plant design in accordance with the guidance that is referred to in the Regulatory Basis section, that is, GDC 2, GDC 60 and 10 CFR 20.1406. As previously stated, GDC 4, GDC 5, GDC 44, GDC 45, and GDC 46 are not applicable to the TBCCWS design.. The staff finds the applicant's September 9, 2010, response to RAI 375, Question 09.02.02-105 acceptable. **RAI 375, Question 09.02.02-105 is being tracked as a confirmatory item** to ensure that the FSAR is revised accordingly.

9.3 Process Auxiliaries

The plant process auxiliaries which are discussed in the following subsections include:

- Compressed Air System
- Process Sampling System
- Equipment and Floor Drainage
- Chemical and Volume Control System

9.3.1 Compressed Air System

9.3.1.1 *Introduction*

The compressed air system (CAS) consists of the compressed air generation system and a compressed air distribution system. Compressed air is supplied to the nuclear island and conventional island compressed air distribution systems. The compressed air generation system is located in the Turbine Building.

9.3.1.2 *Summary of Application*

FSAR Tier 1: As stated in FSAR Tier 1, Section 2.7.12, "Compressed Air System," there are no FSAR Tier 1 entries for this system.

FSAR Tier 2: The applicant has provided a system description in FSAR Tier 2, summarized here, in part, as follows:

The CAS consists of compressors, dryers, filters, receivers, and other equipment required for performing its non-safety-related functions.

The CAS provides pressurized air for the following services:

- Instrument air for non-safety-related valves and other equipment located in the conventional island

- Instrument air for opening the containment ventilation purges dampers (not a safety-related function)

- Instrument air to valves, pumps, and other equipment located in the radioactive waste, decontamination, blowdown demineralization, fuel handling, and other systems for non-safety-related functions

- Service air throughout the plant (for using air-operated tools and purging tanks)

ITAAC: There are no ITAAC items for this system.

Technical Specifications: There are no Technical Specifications for this system.

9.3.1.3 *Regulatory Basis*

The relevant requirements of NRC regulations for this area of review are RG 1.29, RG 1.155, RG 1.68, RG 1.21, RG 1.26, RG 8.8, RG 1.97, and RG 4.21. The associated acceptance criteria, are given in NUREG-0800, Section 9.3.1, Revision 2, “Compressed Air Systems,” and are summarized below. Review interfaces with other SRP sections can also be found in NUREG-0800, Section 9.3.1.

1. GDC 1, “Quality Standards and Records,” as it relates to safety-related structures, systems, or components (SSCs) being designed, fabricated, and tested to quality standards commensurate with the importance of the safety functions to be performed.

2. GDC 2 as it relates to system capability to withstand the effects of earthquakes.

3. GDC 5 as it relates to the sharing of safety-related SSCs.

4. 10 CFR 50.63, “Loss of All Alternating Current Power,” as it relates to necessary support systems providing sufficient capacity and capability to ensure the capability to cope with a station blackout (SBO) event.

Acceptance criteria adequate to meet the above requirements include:

1. Compliance with American National Standards Institute/International Society of Automation Standard ANSI/ISA S7.3-R1981, “Quality Standard for Instrument Air,” with respect to GDC 1.

2. RG 1.29, Regulatory Position C.1 for safety-related SSCs and Regulatory Position C.2 for non-safety-related SSCs with respect to GDC 2.

3. RG 1.155, “Station Blackout.”

9.3.1.4 *Technical Evaluation*

The CAS consists of the instrument air and service air generation systems and a compressed air distribution system.

Instrument air is provided by two oil-free rotary screw compressors that are connected in parallel. During normal operation, one compressor operates to maintain system pressure, and the other compressor is in standby. Each compressor is equipped with an inlet air filter, after-cooler, moisture separator, and air receiver. Duplex pre-filters are provided at the inlet of the instrument air dryer in order to protect the adsorption dryer units. Duplex after-filters prevent the carryover of desiccant dust from the dryer.

Service air is provided by a single oil-free rotary screw compressor. During normal operation, the service air compressor operates continuously. The compressor is equipped with an inlet air filter, after-cooler, moisture separator, air receiver, and filter to condition the compressed air.

In FSAR Tier 2, Section 9.3.1, the applicant described the CAS.

The major components of the CAS are located in the Turbine Building.

The staff reviewed the CAS in accordance with SRP Section 9.3.1. Staff acceptance of the design is based on meeting the requirements of GDC 1, GDC 2, GDC 5, and 10 CFR 50.63. The following is a discussion of the regulatory requirements and how they are met.

GDC 1 requires that safety-related structures, systems, and components be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions performed. The containment isolation valves (CIVs) and penetrations are the only safety-related components in the CAS. The CAS is not required to operate during or following an accident. In the event of an accident, the instrument air motor-operated CIVs isolate instrument air from the containment. Service air manual CIVs are locked closed during normal operation. In accordance with GDC 56, “Primary Containment Isolation,” one locked CIV inside containment and one locked CIV outside containment provide adequate containment isolation. FSAR Tier 2, Chapter 16, Technical Specification 3.6.3 “Containment Isolation Valves,” ensures the service air CIVs are closed in Modes 1, 2, 3, and 4.

In accordance with SRP Section 9.3.1 and to comply with GCD 1, the applicant should address Generic Issue 43, “Reliability of Air Systems,” regarding the reliability of safety-related equipment actuated or controlled by compressed air. Additionally, NUREG-1275, Volume 2, “Operating Experience Feedback Report - Air Systems Problems,” and GL 88-14, “Instrument Air Supply System Problems Affecting Safety-Related Equipment,” also indicates compressed air contamination is a significant contributor to unreliability in safety-related air-actuated equipment. Finally, RG 1.68.3, “Preoperational Testing of Instrument and Control Air Systems,” Regulatory Position C.9 provides guidance on preoperational testing using compressed air supplies with less restrictive air quality requirements. An air system designed to air quality standards of ANSI/ISA S7.3-R1981 helps ensure that the CAS and connected components will perform their safety-function. In FSAR Tier 2, Section 9.3.1.1, “Design Basis,” the applicant stated that the design of the CAS complies with the resolution of Generic Issue 43; however, the applicant did not provide the design air quality standards/specifications of the CAS components. Therefore, in RAI 84, Question 09 03 01-1, the staff requested that the applicant discuss in the FSAR the specifications of the major components of the CAS. In a November 26, 2008, response to RAI 84, Question 09.03.01-1, the applicant clarified that the instrument air is designed to meet the requirements of ANSI/ISA 7.0.01-1996, “Quality Standard for Instrument Air.” The service air connects with the instrument air upstream of the instrument air dryers and filters to maintain acceptable air quality. In SRP Section 9.3.1, the staff endorses the use of ANSI/ISA-S7.3-R1981 for instrument air design. The staff notes that ANSI/ISA 7.0.01-1996 replaced ANSI/ISA S7.3-R1981. These two standards have different requirements and the staff determines on a case by case basis if conformance to ANSI/ISA 7.0.01-1996 is an acceptable alternative to meet the quality requirements for instrument air.

There are no air-operated valves (AOV) or air-operated equipment required to function in response to an accident where the compressed air is provided by the CAS. The only safety-related valves that uses compress air from the CAS are the containment ventilation dampers. Compress air is only used to open the normally closed dampers. Therefore, the staff finds that conformance with ANSI/ISA 7.0.01-1996 is an acceptable alternative to meet the quality requirements for instrument air. The CAS configuration assures that the compressed air that services safety-related valves is maintained of acceptable quality; therefore, the staff considers RAI 84, Question 09.03.01-1 resolved.

In addition to specific design requirements, Generic Issue 43 also stresses the importance of procedures, training, and testing related to loss of air system pressure. Startup Test No. 178 (FSAR Tier 2, Section 14.2.12.13.18, “Pre-core Loss of Instrument Air (Test No. 178)”) tests the effects of a reduction and loss of instrument air on safety-related equipment, which addresses Generic Issue 43 testing requirements. The applicant did not provide a method to implement the procedures and training addressed by Generic Issue 43. Therefore, in RAI 84, Question 09.03.01-2, the staff requested that the applicant create a new COL information item in the FSAR regarding procedures, training, and testing, and to provide a schedule as to when these procedures, training, and testing will be implemented. In a November 26, 2008, response to RAI 84, Question 09.03.01-2, the applicant stated that the CAS is designed to meet ANSI/ISA 7.0.01-1996. The staff’s concerns cited in the Generic Issue 43 are covered in ANSI/ISA 7.0.01. Based on the CAS conformance to ANSI/ISA 7.0.01, the staff concludes that a COL information item concerning the procedures, training, and testing addressed by instrument air design is not necessary. Therefore, the staff considers RAI 84, Question 09.03.01-2 resolved.

To address Generic Issue 43 regarding reliability of safety-related equipment actuated or controlled by compressed air, in FSAR Tier 2, Section 9.3.1.3, “Safety Evaluation,” the applicant stated that the U.S. EPR does not use air operators on safety-related valves, except for the non-safety-related function of opening spring-closed containment ventilation dampers. However, the staff identified that the component cooling water system Piping and Instrument Diagram (P&ID) (FSAR Tier 2, Figures 9.2.2-1, “Component Cooling Water System Trains 1 through 4,” through 9.2.2-3, “Component Cooling Water System Common Loop 2”) showed multiple safety-related, Seismic Category I valves that appear to be air operated. In RAI 84, Question 09.03.01-3, the staff requested that the applicant update FSAR Tier 2, Figures 9.2.2-1 through 9.2.2-3 or FSAR Tier 2, Section 9.3.1.3 to justify and reconcile the conflicting information regarding the use of air operators on safety-related valves throughout the plant. In a November 26, 2008, response to RAI 84, Question 09.03.01-3, the applicant clarified the valve operators in question shown in the component cooling water system P&ID were hydraulic actuators. The staff finds the applicant’s clarification acceptable and considers RAI 84, Question 09.03.01-3 resolved.

The applicant has stated that the CAS does not supply safety-related systems with air or nitrogen. The staff finds that this adequately addresses the Generic Issue 43 concern regarding air quality from backup sources.

FSAR Tier 2, Section 9.3.1.1 indicates the instrument air system is used to provide air to components in the radioactive waste, decontamination, and fuel handling for non-safety-related functions. A review of the system P&ID (FSAR Tier 2, Figure 9.3.1-2, “Compressed Air Distribution System”) showed insufficient detail for the staff to determine whether the CAS could be contaminated through interfaces with radioactive systems or whether provisions are provided for detection of activity and isolation of the system to prevent contamination or a release to the environment. Therefore, in RAI 219, Question 09.03.01-7, the staff requested that the applicant provide an evaluation of whether the CAS could become contaminated through interfaces with radioactive systems. If the system could become contaminated, the staff requested that the applicant provide methods for detection, collection, and control of system leakage to preclude the contamination of other systems and preclude its release to the environment.

In a June 23, 2009, response to RAI 219, Question 09.03.01-7, the applicant stated that the instrument air system is normally pressurized and does not recycle air. The applicant also stated that there is no path for contamination picked up from interfacing systems and carried back through the instrument air system. The CAS is designed with isolation valves upstream of the quick connect to all temporary hose connections that isolate systems and components if contamination is detected. Based on the design features discussed above, the staff concludes that the CAS design minimizes the risk of contaminating the compressed air, if contamination of the system occurs, and the system is designed to isolate the source of contamination from the rest of the system. Therefore, the staff considers RAI 219, Question 09.03.01-7 resolved.

The staff concludes that the design of the CAS satisfies GDC 1 regarding quality standards and records commensurate with the importance of the safety-functions performed by the CAS.

In order for the CAS to meet the requirements of GDC 2 as it relates to SSCs being capable of withstanding natural phenomena, RG 1.29, Regulatory Positions C.1 and C.2 provide an acceptable method to meet this criterion. The applicant provided the seismic design classification for the CAS in FSAR Tier 2, Table 3.2.2-1, that shows the CIVs and penetrations are the only safety-related, Seismic Category I components in the CAS. The remaining components are classified as non-safety, Quality Group E and non-seismic. FSAR Tier 2, Section 9.3.1.2.2, "System Operation," states that the CAS supplies the opening function of the containment ventilation dampers for the containment building ventilation system (CBVS), a non-safety-related function. The CBVS ventilation dampers are safety-related and Seismic Category I (FSAR Tier 2, Figure 9.4.7-2, "Containment Building Low Flow and Full Flow Purge Exhaust Subsystem"). The CAS P&ID (FSAR Tier 2, Figure 9.3.1-2) indicates the connecting piping to the dampers is non-seismic and, therefore, is not consistent with RG 1.29, Regulatory Position C.2. Therefore, in RAI 84, Question 09.03.01-4, the staff requested that the applicant include in the FSAR a justification that demonstrates that a failure of the non-seismic instrument air piping connected to Seismic Category I SSCs will not cause a failure of the Seismic Category I SSCs, therefore, consistent with RG 1.29, Regulatory Position C.2.

The staff reviewed the system failure modes and effects analysis to determine if a failure in the non-safety-related portion of the system would affect the safety-related portion of the system. FSAR Tier 2, Table 3.2.2-1 shows that the non-seismic CAS piping is routed in areas with safety-related and Seismic Category I and II components. During a seismic event, the non-seismic CAS piping could adversely affect Seismic Category I and II components that are located nearby. It was not clear to the staff that the applicant had evaluated the impact of the failure of the Non-Seismic Category I SSCs on the Seismic Category I SSCs. Therefore, in RAI 84, Question 09.03.01-5, the staff requested that the applicant include in the FSAR an evaluation of the impact of the failure of the Non-Seismic Category I SSCs on the Seismic Category I SSCs.

In a January 21, 2009, response to RAI 84, Questions 09.03.01-4 and 09.03.01-5, the applicant clarified that non-seismic lines and associated equipment are routed, to the extent possible, outside of safety-related structures and areas to avoid potentially adverse interactions. In the event that this routing is not possible and non-seismic lines must be routed in safety-related areas, the non-seismic items are evaluated for seismic interactions. The methodology used to evaluate the interactions between non-safety related and safety-related components is described in FSAR Tier 2, Section 3.7.3.8. The staff evaluation of FSAR Tier 2 Section 3.7.3.8 is documented in Section 3.7.3 of this SER. Following the methodology described in FSAR Tier 2, Section 3.7.3.8, the applicant has identified those portions of the systems that may interact with Seismic Category I SSCs and performed an impact evaluation that verified that there are no adverse impacts from the failure of the non safety-related CAS components that required that these components be classified as Seismic Category II. Therefore, the staff considers RAI 84, Questions 09.03.01-4 and 09.03.01-5 resolved.

Based on the above discussion, the staff concludes that the design of the CAS satisfies GDC 2 regarding protection from the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, floods, and external missiles.

Compliance with GDC 5 requires that SSCs important to safety not be shared among nuclear power units unless it can be shown that such sharing will not impair their ability to perform their safety functions. The U.S. EPR is designed as a single facility, so the requirement of GDC 5 for sharing of systems between units does not apply.

The CAS instrument air compressors and service air compressor are non-1E powered, and in the event of a loss of offsite power, they do not receive power from the emergency diesel generators. Similarly, during an SBO, the CAS compressors do not receive power from either of the SBO generators.

The CAS is not required to operate during an SBO. Therefore, the staff finds the design of the CAS satisfies the requirement of 10 CFR 50.63 regarding the capability for responding to an SBO.

ITAAC: There is no specific ITAAC for the CAS. The staff reviewed the CAS in accordance with SRP Section 14.3.7 and agrees that no ITAAC are needed for the CAS.

Initial Plant Testing: The initial plant testing associated with the CAS includes:

Test No. 178 for, "Pre-core Loss of Instrument Air"

- The applicant has not proposed a specific test to address the operability of the CAS. Test No. 178 states that: "The CAS test, in conjunction with this test satisfies the requirements of RG 1.68.3, Regulatory Positions C.1-C.11."

- The staff reviewed Test Abstract No. 178 and concludes that the test meets the recommendations of RG. 1.68.3, therefore, the staff finds Test No. 178 is an adequate test for the CAS.

Based on the initial plant testing identified for the CAS, the staff concluded that the applicant has proposed an adequate initial plant testing to demonstrate the proper construction and operation of the CAS.

Technical Specifications: There are no Technical Specifications applicable to the CAS. The staff reviewed the CAS against 10 CFR 52.47, "Contents of Applications; Technical Information," and the Standard Technical Specifications and concluded that no TS are needed for the CAS.

9.3.1.5 *Combined License Information Items*

There are no COL information items from FSAR Tier 2, Table 1.8-2 that affect this section.

9.3.1.6 *Conclusions*

The staff concludes that the CAS design is acceptable and complies with GDC 1 and GDC 2 as to quality standards and seismic design, and 10 CFR 50.63 as to SBO.

9.3.2 Process Sampling Systems

9.3.2.1 *Introduction*

The process sampling system (PSS) is made up of the nuclear sampling system (NSS), secondary sampling system (SECSS), severe accident sampling system (SASS), and hydrogen monitoring system (HMS). The PSS allows the plant staff to obtain liquid and gaseous samples to enable them to determine the physical and chemical characteristics of certain fluids by measurement and analysis. Centralized and local facilities permit samples to be taken of primary and secondary coolant, containment atmosphere, liquid and gaseous waste treatment systems, and the IRWST. The specifics of the HMS are discussed in FSAR Tier 2, Section 6.2.5, "Combustible Gas Control in Containment," and in Section 6.2.5, "Combustible Gas Control in Containment," of this report.

9.3.2.2 *Summary of Application*

FSAR Tier 1: There are no FSAR Tier 1 entries for this area of review.

FSAR Tier 2: The applicant has provided a system description in FSAR Tier 2, Section 9.3.2, "Process Sampling Systems," summarized here, in part, as follows:

The PSS collects liquid and gaseous samples from the nuclear, secondary, and severe accident sampling systems. The NSS is contained within the Nuclear Island (NI) and takes liquid samples from the loop 3 crossover leg (reactor coolant system (RCS)), liquid phase in the pressurizer (RCS), loop 1 hot leg (RCS), safety-injection system accumulators (four), reactor boron and water makeup system, fuel pool cooling system, fuel pool purification system, coolant degasification system, and coolant treatment system (CTS). Gaseous samples are obtained from the gaseous waste processing system, coolant supply and storage system, NSS backfeed vessel, and NI drain/vent system. The SECSS takes liquid samples from the four steam generators by way of the steam generator blowdown sampling system and at a centralized sampling and analysis facility in the Turbine Building where steam-condensate-feedwater cycle and the quality of various other process fluids are examined. The SASS obtains samples from equipment and annular rooms inside containment, and from the IRWST. The NSS and the SECSS are both in service during normal plant operations; whereas, the SASS is in operation only during post-accident conditions. Liquid samples include both automatic, continuous samples (reactor coolant) and manual grab samples taken under all plant conditions. Gaseous samples are manual and typically utilize a special transportable gas sample vessel which is connected to the system through quick connect/disconnect connections. The involved system is purged before sampling, and liquid samples are recycled to minimize waste.

ITAAC: There are no ITAAC items for this area of review.

Technical Specifications: FSAR Tier 2, Chapter 16, Section 5.5, "Program and Manuals," of the Technical Specifications contains three programs that relate to the PSS. Section 5.5.8, "Steam Generator (SG) Program," requires SG sampling. Technical Specification 3.4.16, "Steam Generator Tube Integrity," refers the reader to Section 5.5.8 when sampling calls the integrity of the steam generator tubes into question. Section 5.5.9, "Secondary Water Chemistry Program," deals with sampling of secondary water. Technical Specification 3.7.17, "Secondary Specific Activity," deals with specific activity of secondary water. Section 5.5.11, "Gaseous Waste Processing System Radioactivity Monitoring Program," deals with monitoring the gaseous waste processing system. Technical Specification 3.4.12, "RCS Operational Leakage," deals with RCS leak detection instrumentation and requires grab samples when the instrumentation is inoperable. Technical Specification 3.4.15, "RCS Specific Activity," establishes the limits for RCS specific activity in terms of Dose Equivalent Iodine (DEI) and Dose Equivalent Xenon.

Also included in the Technical Specifications are:

- Accumulator Boron Concentration and ^{10}B Atom percent, FSAR Tier 2, Chapter 16, B 3.5.1, "Accumulators"
- IRWST Boron Concentration and ^{10}B Atom percent, FSAR Tier 2, Chapter 16, B 3.5.4, "In-Containment Refueling Water Storage Tank – Operating"
- Extra Borating System (EBS) Tanks Boron Concentration and ^{10}B Atom percent, FSAR Tier 2, Chapter 16, B 3.5.5, "Extra Borating System"

9.3.2.3 *Regulatory Basis*

The relevant requirements of NRC regulations for this area of review, and the associated acceptance criteria, are given in NUREG-0800, Section 9.3.2, "Process and Post-accident Sampling Systems," and are summarized below. Review interfaces with other SRP sections can also be found in NUREG-0800, Section 9.3.2.

1. GDC 2, as it relates to the ability of the PSS to withstand the effects of natural phenomena.

4. GDC 13, "Instrumentation and Control," as it relates to monitoring variables that can affect the fission process, the integrity of the reactor core and the reactor coolant pressure boundary (RCPB).

5. GDC 14, "Reactor Coolant Pressure Boundary," as it relates to assuring the integrity of the RCPB by sampling for chemical species that can affect the RCPB.

6. GDC 26, "Reactivity Control System Redundancy and Capability," as it relates to reliably controlling the rate of reactivity changes by sampling boron concentration.

7. GDC 41, "Containment Atmosphere Cleanup," as it relates to reducing the concentration and quality of fission products released to the environment following postulated accidents by sampling the chemical additive tank for chemical additive concentrations to ensure an adequate supply of chemicals for meeting the material compatibility requirements and the elemental iodine removal requirements of the containment spray and recirculation solutions following a postulated accident.

8. GDC 60, as it relates to the capability of the PSS to control the release of radioactive materials to the environment.

9. GDC 63, as it relates to detecting conditions that may result in excessive radiation levels in the fuel storage and radioactive waste systems.

10. GDC 64, "Monitoring Radioactivity Releases," as it relates to monitoring the containment atmosphere and plant environs for radioactivity.

11. 10 CFR 50.34(f)(2)(xxvi), "Contents of applications; technical information," provides equivalent requirements for those applicants subject to 10 CFR 50.34(f).

12. 10 CFR 52.47(b)(1), which requires that a design certification application contain the proposed ITAAC that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a plant that incorporates the design certification is built and will operate in accordance with the design certification, the provisions of the Atomic Energy Act of 1954, and NRC regulations.

13. 10 CFR 20.1101(b), as it relates to providing engineering controls based upon sound radiation protection principles to achieve occupational doses and doses to members of the public as low as reasonably achievable (ALARA).

14. 10 CFR Part 50, Appendix A, GDC 1, as it relates to the design of the PSS and components in accordance with standards commensurate with the importance of their safety functions.

Acceptance criteria adequate to meet the above requirements include:

1. NUREG-0737, Item III.D.1.1, "Clarification of TMI Action Plan Requirements," as it relates to the provisions for a leakage control program to minimize the leakage from those portions of the PSS outside of the containment that contain or may contain radioactive material following an accident.

2. RG 1.21, "Measuring, Evaluating, and Reporting Radioactive Material in Liquid and Gaseous Effluents and Solid Waste," Regulatory Position C.2.

3. The Electric Power Research Institute (EPRI) PWR Water Chemistry Guidelines are used to meet the requirements of the relevant GDC.

4. The following guidelines should be used to determine the acceptability of the PSS functional design:

   - RG 1.21, Regulatory Position C.1.21

   - RG 8.8, Regulatory Positions C.2.d(2), C.2.f.(3), and C.2.f.(8)

5. RG 1.26, Regulatory Positions C.1, C.2, and C.3

6. RG 1.29, Regulatory Positions C.1, C.2, C.3, and C.4

7. RG 1.97, "Criteria for Accident Monitoring Instrumentation for Nuclear Power Plants." Components and piping downstream of the second isolation valve may be designed to

Quality Group D and Non-Seismic Category I requirements, in accordance with RG 1.26, Regulatory Position C.3.

9.3.2.4 *Technical Evaluation*

The staff reviewed the PSS in accordance with NUREG-0800, Section 9.3.2. Staff acceptance of the PSS is based on the design meeting the requirements of 10 CFR 20.1101(b), GDC 1, GDC 2, GDC 13, GDC 14, GDC 26, GDC 41, GDC 60, GDC 63, GDC 64, and TMI Action Plan Item III.D.1.1 (NUREG-0737). Review of FSAR Tier 1 documentation did not provide any supporting information for this review. The results of this technical evaluation will be presented separately for each of the sub-groupings of the PSS:

- Nuclear Sampling System
- Secondary Sampling System
- Severe Accident Sampling System (This sub-grouping of the PSS is in lieu of a Post-Accident Sampling System (PASS) as identified in NUREG-0800, Section 9.3.2.)
- Hydrogen Monitoring System

Representative Sampling GDC 13, GDC 14, GDC 26, GDC 60, GDC 63, and GDC 64 (NSS, SECSS, and SASS)

NUREG-0800, Section 9.3.2 acceptance criteria for the locations sampled are based on compliance with GDC 13, GDC 14, GDC 26, GDC 60, and GDC 64. Not all these GDC pertain to each required sample point. Sample locations are recommended based on the need to monitor variables that affect the fission process (GDC 13 and GDC 26), control corrosive contaminants (GDC 13 and GDC 14), control the release of radioactive materials to the environment (GDC 60), control excessive radiation levels in the fuel storage and radioactive waste systems (GDC 63), and monitor the containment atmosphere and plant environs for radioactivity (GDC 64). NUREG-0800, Section 9.3.2, SRP Acceptance Criterion 1 provides a table detailing the recommended sample points and GDC bases.

The staff reviewed the description of the NSS in FSAR Tier 2, Section 9.3.2 and the associated diagrams to determine if the NSS can achieve the sampling of the RCS to provide plant operators with information supporting the GDC given above.

Sampling lines from the RCS liquid phase are shown in FSAR Tier 2, Figure 9.3.2-1, “Nuclear Sampling System.” Four distinct locations for sampling the RCS liquid phase are identified:

- RCS Loop 1 (hot leg)
- RCS Loop 3 (intermediate leg)
- Pressurizer liquid phase
- Letdown upstream of the demineralizer and pre-filter

Any of these sample locations will provide representative samples of the radionuclide content of the RCS liquid phase. This is because each identified sample line is taken directly from a continuously flowing portion of the RCS (both the loops and the letdown flow are continuously in operation during plant operation). The average turnover rate of the RCS volume through these identified lines is measured in minutes. Thus, the sample lines when properly flushed will be able to provide samples that represent the portion of the flowing system to which they are connected. The identified sample points will also provide representative sampling for boron (reactivity control) and chemical contaminants that could affect the integrity of the RCPB. Additionally, the letdown process flow is continuously monitored with an adjacent-to-line radiation monitor that provides for monitoring of total activity of the RCS. This is essential for early detection of fuel defects which can affect dose to workers and increase radioactive releases to the environment, if not effectively monitored and controlled.

Sampling of the pressurizer for boron is necessary to ensure that minimum boron concentration differences exist to avoid reactivity concerns during operation. Process instrumentation is provided at the sample sink for the NSS. However, FSAR Tier 2, Section 9.3.2 does not state if this is continuous or intermittent flow. Additionally, there is a potential discrepancy between FSAR Tier 2, Table 9.3.2-1 and FSAR Tier 2, Section 9.3.2.3, “Safety Evaluation,” as to which parameters are measured with process instruments. Therefore, in RAI 113, Question 09.03.02-2, the staff requested that the applicant identify in the FSAR the parameters that are measured using process instruments at the primary sample sink for RCS, pressurizer, and CVCS. In a December 8, 2008, response to RAI 113, Question 09.03.02-2, the applicant identified a change to the statements in the FSAR regarding the function of the NSS continuous monitoring function. The applicant clarified that this system provides sample information regarding specific conductivity and not chlorides. The staff confirmed that Revision 1 of the FSAR, dated May 29, 2009, contains the changes committed to in the RAI response. Accordingly, the staff finds that the applicant has adequately addressed this issue and, therefore, considers RAI 113, Question 09.03.02-2 resolved.

Representative sampling and analysis of both the liquid and steam phase of the RCS during all phases of operation is an important aspect in controlling offsite doses. The pressurizer gas space is a collection point for RCS noble radioactive gases during shutdown and can contribute significantly to the radioactive gaseous effluents unless it can be sampled and analyzed for these radionuclides. A sample line from the pressurizer gas space is not provided based on the diagrams presented in FSAR Tier 2, Section 9.3.2. Thus, during a plant shutdown, the noble gas content of the pressurizer gas phase cannot be determined. This may be significant if it becomes necessary to discharge the pressurizer gas space. Therefore, in RAI 113, Question 09.03.02-3, part 2, the staff requested that the applicant provide in the FSAR the mechanism for assessing the concentration of fission products, hydrogen and oxygen in the pressurizer gas phase, since no sample line for this portion of the RCS is shown in FSAR Tier 2, Figures 9.3.2-1 to 9.3.2-3. In a December 8, 2008, response to RAI 113, Question 09.03.02-03, part 2, the applicant stated that the pressurizer gas phase is not directly sampled by the PSS. FSAR Tier 2, Section 5.4.10.2.1, “Pressurizer Construction,” identifies that the pressurizer gas is continuously vented to the reactor coolant drain tank (RCDT) in the nuclear island drain and vent system.

FSAR Tier 2, Section 9.3.2.1, “Design Basis,” Figures 9.3.2-1 to 9.3.2-2 identifies the RDCT sample point as the mechanism of sampling the pressurizer. In a December 8, 2008, response to RAI 113, Question 09.03.02-3, the applicant identified other gaseous inputs to the RCDT in addition to the vented pressurizer gas phase fluids. Both the noble gas content and the oxygen content of the gas phase of the pressurizer are important chemistry operational, start-up, and shutdown parameters that need to be monitored on a routine basis. Therefore, in RAI 185, Question 09.03.02-09, the staff requested that the applicant address the following issues:

- Continuous venting of the pressurizer gas phase

- A calculation demonstrating the methodology for calculating hydrogen concentration in the RCS based on the multiple inputs to the RCDT

- Describe the method of assurance of equilibrium in the concentrations of hydrogen between the various RCS loops and pressurizer

In a May 19, 2009, response to RAI 185, Question 09.03.02-09, the applicant clarified the operation for the continuous venting of the pressurizer and identified that the hydrogen content of the RCS would be determined by using a pressurized liquid sample directly from the RCS. This sampling would be done in all modes ensuring appropriate concentrations for hydrogen and oxygen were not exceeded. This is the same method of sampling currently used in U.S. pressurized water reactors (PWRs) and is an acceptable technique. The combination of continuous pressurizer venting and sampling of the RCS liquid phase for hydrogen content provides an adequate means for controlling hydrogen in the pressurizer gas phase, thus eliminating the need for a separate pressurizer gas phase sample line.

The applicant also indicated that FSAR Tier 2, Section 5.4.10.2.3, “Pressurizer Operation,” will be changed as follows to provide clarification:

> During normal operations, the pressurizer is vented by a continuous vent. During plant start-up and shutdown operations, the pressurizer is vented by a vent of greater capacity than the continuous vent used during normal operations.

The staff concludes that the applicant’s May 19, 2009, response to RAI 185, Question 09.03.02-09, and the proposed FSAR change in the response to RAI 185, Question 09.03.02-09 is acceptable. The Staff has confirmed that the change has been incorporated in Revision 2 of the FSAR and therefore considers RAI 185, Question 09.03.02-9 resolved.

Provisions have been made in the plant design as shown in FSAR Tier 2, Figure 9.3.2-1 (all sheets) for sampling of the spent fuel pool, waste liquid effluent tanks, gaseous waste processing systems, and for purging and minimizing discharged radioactive liquid (through the use of a water recovery system). The system design allows for the representative sampling of each of these systems so that chemical analysis critical to reactivity, corrosion control, and radioactive effluents monitoring and sampling can be performed. Provisions to monitor and sample system process streams and liquid and gaseous effluent discharge points for the presence of radioactive materials are described in FSAR Tier 2, Section 11.5.3, “Effluent Monitoring and Sampling,” FSAR Tier 2, Section 11.5.4, “Process Monitoring and Sampling,” FSAR Tier 2, Table 11.5-1, “Radiation Monitor Detector Parameters,” and FSAR Tier 2, Figure 11.5-1, “Radioactive Effluent Flow Paths with Process and Effluent Radiation Monitors.” The staff’s evaluation of the adequacy of these provisions against NUREG-0800, Sections 11.2 to 11.5 acceptance criteria and resolutions of associated RAIs are presented in Sections 11.2 to 11.5 of this report.

SRP Section 9.3.2 also recommends that the refueling (borated) water storage tank should be a normal process sample location. The equivalent location in the U.S. EPR design is the IRWST. However, the only provision for sampling the IRWST is via the SASS, and this system as described in FSAR Tier 2, Sections 9.3.2.2.1.3, “Severe Accident Sampling System,” 9.3.2.2.3, “System Operation,” and 9.3.2.3 is only operated during a severe accident. In RAI 185, Question 09.03.02-10, the staff requested that the applicant revise the FSAR to identify recirculation and sampling of the IRWST during the fuel cycle as a specific function for the LHS pumps (and not with the PSS). In an April 22, 2009, response to RAI 185, Question 09.03.02-10, the applicant stated that the low-head safety injection pump (LHSI) pumps will be used to recirculate the IRWST during fuel cycles. The staff finds the applicant has adequately addressed this issue and, therefore, considers RAI 185, Question 09.03.02-10 resolved.

In a December 03, 2009, response to RAI 23, Question 12.03-12.04-1, the applicant stated that a U.S. EPR design feature which demonstrated compliance with 10 CFR 20.1406 was the ability to sample tanks from the bulk volume to avoid low points and sediment traps. In follow-up RAI 223, Question 09.03.02-14, the staff requested that the applicant provide clarification of how tanks that were not part of the PSS would be sampled to comply with SRP Section 9.3.2 regarding, "For tanks, provisions should be made to sample the bulk volume of the tank and to avoid sampling from low points or from potential sediment traps." The process of sampling tanks needs to ensure that, "… provisions should be made to sample the bulk volume of the tank and to avoid sampling from low points or from potential sediment traps." For sampling of process streams, "sample points should be located in turbulent flow zones," in accordance with RG 4.21, Regulatory Position C.6.

RAI 223, Question 09.03.02-14, Item A is being tracked as an open item.

Since the sample points identified by the applicant, parameters sampled, and provisions for representative sampling comply with those recommended in SRP Section 9.3.2 for the NSS, SECSS, and SASS, the staff finds that, except for RAI 223, Question 09.03.02-14, Item A, which is being tracked as an open item, GDC 13, GDC 14, GDC 26, GDC 41, GDC 60, GDC 63, and GDC 64 are met with respect to the sampling locations and parameters sampled.

Nuclear Sampling System

There are no FSAR Tier 1 entries for this system.

GDC 41

The NSS is described in FSAR Tier 2, Section 9.3.2.1 as being able to control fission products and reduce the concentration of fission products released to the environment. GDC 41 relates to reducing the concentration and quality of fission products released to the environment following a postulated accident. The system as described and as shown in FSAR Tier 2, Figure 9.3.2-1 does not appear to have functions that "reduce" or "control" fission products. In RAI 113, Question 09.03.02-3, Part 1, the staff requested that the applicant provide additional details of these systems showing the control of fission products, and the reduction of fission products released. In a December 8, 2008, response to RAI 113, Question 09.03.02-3, Part 1, the applicant identified a proposed change to the statements in the FSAR regarding the function of the NSS. The applicant clarified that this system provides sample information regarding radioactivity that is used for making management decisions regarding an accident condition. The staff reviewed the proposed FSAR revisions and finds them acceptable. The staff confirmed that Revision 1 of the FSAR, dated May 29, 2009, contains the changes committed to in the RAI response. Accordingly, the staff finds the applicant has adequately addressed this issue and, therefore, considers RAI 113, Question 09.03.02-3, Part 1 resolved.

In RAI 223, Question 09.03.02-14, the staff also requested that the applicant provide specific information on the nature of decontaminating fluids used in the NSS, describe how often they would be used, and provide the procedural or engineering controls that are defined to ensure that the decontamination chemicals do not get into the PSS or the systems that they are sampling (since during normal sampling, the flushed liquid is returned to the parent system). **RAI 223, Question 09.03.02-14, Item B is being tracked as an open item.**

GDC 60

Per SRP Section 9.3.2, GDC 60 is met if the sampling system has any of the following features:

- Provisions to purge and drain sample streams back to the system of origin or to an appropriate waste treatment system
- Flow restriction devices installed in sample lines to limit flow and subsequent release of radioactive materials should a sample line rupture
- CIVs which fail in the closed position

FSAR Tier 2, Sections 9.3.2.1, 9.3.2.2.1, "General Description," and 9.3.2.3 identify these GDC requirements. Sample line flush for sampling for most systems is returned to the system or, in the case of the RCS, returned to the backfeed tank or to the nuclear island drain and vent system (NIDVS). In other cases, the flushed liquid is directed to the liquid waste system via engineered piping. The RCS sample lines all have inboard and outboard, motor-operated, isolation valves to contain RCS volume on appropriate signals; however, these valves fail as-is rather than fail closed. FSAR Tier 2, Section 9.3.2.3 states that the NSS and SASS sample lines contain passive flow restrictions (equivalent to line size) to limit loss of coolant following a rupture of a sample line. The sample line sizes and flow restricting orifice sizes (if used) were not provided in the FSAR or in the line diagrams of the PSS. Therefore, in RAI 87, Question 09.03.02-1, the staff requested that the applicant clarify sample line sizes and flow restricting orifice sizes (if used).

In a November 10, 2008, response to RAI 87, Question 09.03.02-1, the applicant clarified that the passive flow restrictions would be provided by the sample line sizes between the sample line CIVs. The line sizes are provided in FSAR Tier 2, Table 6.2.4-1, "Containment Isolation Valve and Actuator Data." For the NSS sample lines, the passive flow restrictions are 6.35 mm (0.25 in.); and for the SASS sample lines, the passive flow restrictions are 9.525 mm (0.375 in.).

Provisions to monitor and sample systems serviced by the nuclear sampling system are described in FSAR Tier 2, Section 11.5.4.6, "Nuclear Sampling System," and FSAR Tier 2, Table 11.5-1, "Radiation Monitor Detector Parameters." The staff evaluated whether these provisions were consistent with NUREG-0800, Sections 11.2 to 11.5 acceptance criteria. Resolutions of associated RAIs are presented in Sections 11.2 to 11.5 of this report.

As stated in SRP Section 6.2.4, "Containment Isolation System," Acceptance Criteria 10 to meet the requirements of GDC 55, "Reactor Coolant Pressure Boundary Penetrating Containment," and GDC 56, upon loss of actuating power, automatic CIVs should take the position of greatest safety. For lines equipped with motor-operated valves, a loss of actuating power leaves the affected valve in the "as-is" position, which may be the open position. However, redundant isolation barriers ensure that the isolation function for the line is satisfied. All power-operated isolation valves should have position indications in the main control room. The NSS and the SASS sample lines have redundant CIVs which are motor operated. These CIVs all receive automatic containment isolation signals, and they all have position indication in the main control room. See FSAR Tier 2, Table 6.2.4-1; FSAR Tier 2, Section 6.2.4.5, "Instrumentation Requirements"; and FSAR Tier 1, Table 3.5-2, "Containment Isolation Equipment I&C and

Electrical Design.” Based on these design features, the staff finds that the applicant complies with the requirements of GDC 60. The staff concludes the NSS meets the requirements of GDC 41 and GDC 60.

10 CFR 50.34(f)(2)(xxvi)

The discussion of the NSS compliance with 10 CFR 50.34(f)(2)(xxvi) is included with the discussion of the SASS.

Secondary Sampling System

The staff’s acceptance of the SECSS is based on GDC 13, as it relates to providing adequate instrumentation and GDC 14, as it relates to performing the required testing to assure the integrity of the RCPB, specifically by ensuring that corrosion-induced failure of the secondary side of the steam generator tubes will not occur. This is accomplished by sampling for chemical properties that can affect the secondary side of the steam generator (and the provision of appropriate instrumentation to conduct the required sampling).

There are no FSAR Tier 1 entries for this system.

The SECSS (FSAR Tier 2, Section 9.3.2.2.1.2, “Secondary Sampling System”) has the capability to sample each of the four steam generator blowdown lines, condensate hotwell, and condensate polisher effluent. These sample points conform to those recommended by SRP Section 9.3.2 for a PWR. FSAR Tier 2, Section 9.3.2.2.1.2 also describes the capability to sample the steam generators in three locations. No details of these sample locations are provided in this section or in the figures in FSAR Tier 2, Section 9.3.2. FSAR Tier 2, Section 10.4.8, “Steam Generator Blowdown System (PWR),” gives a general description of the blowdown system but no other specifics regarding the sampling of the blowdown system. The sample locations are important as they will identify chemistry conditions in the steam generators which can be adverse to the integrity of the RCPB. FSAR Tier 2, Figure 10.4.8-1, “Steam Generator Blowdown System Discharge and Cooling,” (Sheet 1 of 3) shows two 1.9 cm (0.75 in.) lines that go to the sampling system, but there is no indication of a third. FSAR Tier 2, Section 10.4.8 contained no details to describe how the SECSS provides representative sampling to ensure integrity of the RCPB, or how radioactivity in the secondary system is representatively monitored, sampled, and analyzed so that effluent releases can be accurately monitored. Therefore, in RAI 113, Question 09.03.02-5, the staff requested that the applicant provide further details regarding the location of the sample lines from the steam generator blowdown line demonstrating that representative sampling for radionuclides and contaminants will be achieved. The staff also requested that the applicant provide confirmation that limits on secondary system contaminants will conform to EPRI PWR Secondary Water Chemistry Guidelines to ensure integrity of the RCPB (see NUREG-0800, Section 10.4.6). In a December 8, 2008, response to RAI 113, Question 09.03.02-5, the applicant stated that the sample points for the SG are identified on FSAR Tier 2, Figure 10.4.8-1, Sheet 1. The applicant also identified additional sampling points directly off the secondary side of each SG downstream of several blowdown components. These sample points are found in FSAR Tier 2, Figure 5.1-4, “RCS Piping and Instrumentation Diagram.” The staff has reviewed the response, and finds it acceptable. Therefore, the staff considers RAI 113, Question 09.03.02-05 resolved.

In RAI 223, Question 09.03.02-15, the staff requested that the applicant provide clarification as to which specific systems and subsystems have radiation monitors specifically associated with the function and monitoring of the individual system. The staff also requested that the applicant describe the interface between the process sampling system described in FSAR Tier 2, Section 9.3.2 and the process and effluent monitoring system described in FSAR Tier 2, Section 11.5. Additionally, the staff requested that the applicant confirm that the systems share common piping or components or are the systems are completely separate.

In an August 24, 2009, response to RAI 223, Question 09.03.02-15, the applicant stated that the PSS is a subset of the process and effluent monitoring system, which is described in FSAR Tier 2, Section 11.5. Provisions to monitor and sample the secondary system are described in FSAR Tier 2, Sections 11.5.4.1, “Main Steam Radiation Monitoring System,” 11.5.4.2, “Main Condenser Evacuation Radiation Monitoring System,” 11.5.4.3, “Steam Generator Blowdown Radiation Monitoring System,” FSAR Tier 2, Table 11.5-1, “Radiation Monitor Detector Parameters,” and FSAR Tier 2, Figure 11.5-1, “Radioactive Effluent Flow Paths with Process and Effluent Radiation Monitors." The staff evaluated whether these provisions were consistent with the acceptance criteria in NUREG-0800, Sections 11.2 to 11.5, and also whether they compared with resolutions of associated RAIs that are presented in Sections 11.2 to 11.5 of this report. In addition, the applicant noted that FSAR Tier 2, Table 7.5-1, “Initial Inventory of Post-Accident Monitoring Variables,” Sheet 2 of 2 would be revised to delete the reference to “SG secondary side sample radiation monitors” as the only radiation monitors on the blowdown lines from each steam generator. The staff has reviewed the proposed FSAR revisions and considers them acceptable. The staff has confirmed the changes are included into Revision 2 of the FSAR and considers them acceptable.

The staff concludes the SECSS meets the requirements of GDC 13 and GDC 14, since it provides for sampling the locations and parameters necessary to ensure that corrosion-related failure of the secondary side of the steam generator tubing will not occur, as well as, the necessary instrumentation to ensure adequate monitoring.

Severe Accident Sampling System

There are no FSAR Tier 1 entries for this system.

Staff acceptance of the SASS is based on consistency with the guidance of NUREG-0737 Item III.D.1.1 or the requirements of 10 CFR 50.34(f)(2)(xxvi) as it relates to a program and provisions for leakage control and detection for systems outside containment that contain (or might contain) source term radioactive materials following an accident. It is also based on the applicant complying with GDC 64 as it relates to the requirement that a post-accident sampling system have a specific capability for the collection and analysis of highly radioactive samples for boron, containment recirculation fluid (sump) pH, and containment atmosphere for hydrogen and other fission products. The SASS must also comply with GDC 60 and GDC 63 as they relate to minimization of radiation exposure to plant personnel.

GDC 64 and 10 CFR 50.34(f)(2)(xxvi)

A specific PASS, is not the only way that an applicant can be consistent with NUREG-0800, Section 9.3.2, provided that the plant has a determined process for obtaining highly radioactive samples from the RCS, containment sump, and containment atmosphere. The process in place must support emergency planning by providing the data necessary to classify the fuel damage level, analyze hydrogen in the containment atmosphere, and not reduce the effectiveness of emergency plans. Additionally, the offsite capability to monitor radioactivity, including radioactive iodides, must be maintained. For the U.S. EPR, the SASS provides dedicated capability to sample the IRWST (equivalent to the containment sump) and containment atmosphere. The NSS is relied upon to provide post-accident samples from the RCS, and the HMS Section 6.2.5, provides the capability to monitor containment hydrogen.

FSAR Tier 2, Section 9.3.2.3 identifies the overall function of the SASS as obtaining and analyzing gaseous and liquid samples from the containment atmosphere and IRWST following a severe accident. The sampling locations within the containment and the connections to the SASS panel are shown in FSAR Tier 2, Figure 9.3.2-2, "Severe Accident Sampling System." The IRWST outer annulus and inner annulus pool samples can all be obtained at the SASS panel. However, GDC 64 states, in part, that means shall be provided for monitoring spaces containing components for recirculation of loss-of-coolant accident (LOCA) fluids. In an August 24, 2009, response to RAI 223, Question 09.03.02-15, the applicant stated that no radiation monitors are associated with the SASS. Given that the SASS may contain post-LOCA fluids, in RAI 298, Question 09.03.02-17, follow-up to RAI 223, Question 9.3.2-15, the staff requested that the applicant describe the means that will be used to monitor SASS rooms for radioactivity to comply with GDC 64 during post-LOCA sampling vital area missions and maintain ALARA worker exposure ALARA during operation of the SASS. In an August 31, 2010, response to RAI 298, Question, 09.03.02-17, the applicant stated that the SASS has gas and liquid recirculation and dilution sampling modules located in Safeguard Building 4 that dilute post-LOCA fluids and gases prior to pumping them to the manual sampling station in the Fuel Building. The dilution modules are capable of diluting samples by up to a factor of 1,000, which would be established as the default setting by plant start-up procedures for the SASS. Plant personnel would not need to access the sampling modules in the Safeguard Building during an accident, and would, instead, only need to access the fuel building sampling station. Since the dilution of the samples significantly reduces the radiation levels associated with the post-LOCA samples, and the sampling station is also shielded and designed to re-inject excess sample back into containment, the staff considers a portable radiation monitor sufficient for monitoring the fuel building sample station and complies with the requirements of GDC 64. The staff also finds the above design features sufficient to maintain worker exposure ALARA during use of the SASS and, therefore, complies with 10 CFR 20.1101(b). In an August 31, 2010, response to RAI 298, Question 09.03.02-17, the applicant committed to revising FSAR Tier 2, Section 9.3.2.3, "Safety Evaluation," to state the dilution factors for the SASS, including the default setting. The applicant also committed to revising FSAR Tier 2, Figure 12.3.-77, "Access Routes to Sample Point at Elevation – 16 Ft," to add the word, "SASS," to the title to correct the location of the sampling point shown in FSAR Tier 2, Figure 12.3-77 and to correct the elevation in the title to "-11 Ft". The staff will confirm that the proposed revisions to FSAR Tier 2, Section 9.3.2.3 and FSAR Tier 2, Figure 12.3-77 are incorporated into a future revision of the FSAR. **RAI 298, Question 09.03.02-17 is being tracked as a confirmatory item.**

FSAR Tier 2, Section 9.3.2.3 identifies the SASS as being able to sample containment atmosphere for gases (hydrogen and radioactive) in the post accident condition. Continuous gaseous hydrogen monitoring is not part of the SASS, but is the function of the HMS. Although the hydrogen monitoring is performed by the HMS, the mechanism for gas grab sampling or continuous monitoring during a severe accident for hydrogen and radioactive gases is not identified specifically in this section of the FSAR. GDC 64 requires that, "[m]eans shall be provided for monitoring the reactor containment atmosphere, spaces containing components for recirculation of loss-of-coolant accident fluids, effluent discharge paths, and the plant environs for radioactivity that may be released from normal operations, including anticipated operational occurrences, and from postulated accidents."

Thus, fission product gases need to be sampled and analyzed during normal operation and in post-accident situations. In RAI 185, Question 09.03.02-11, the staff requested that the applicant identify the system used to obtain containment gas samples in the event that the containment radiation monitor is out of service. **RAI 185, Question 09.03.02-11 is being tracked as an open item.**

Except for RAI 185, Question 09.03.02-11, and since the SASS provides the capability to sample highly radioactive samples from the containment atmosphere and containment recirculation fluid, the staff finds that the SASS complies with GDC 64.

FSAR Tier 2, Section 9.3.2.3 states that the design of the PSS satisfies 10 CFR 50.34(f)(2)(xxvi) regarding provisions for a leakage detection and control program minimizing the leakage from those portions of the PSS outside of the containment that contain or may contain radioactive material following an accident. This is accomplished as follows:

- The NSS samples the RCS to provide information necessary to assess and control the plant (to maintain sub-criticality) under accident conditions.

- The SASS obtains and analyzes gaseous samples from the containment atmosphere following a severe accident for the purpose of confirming whether the containment atmosphere contains airborne radioactivity.

- The NSS and SASS contain proper equipment to prevent unnecessarily high exposures to workers and minimize leakage from the system to ALARA.

- Safety-related containment isolation valves close on receipt of a containment isolation signal and contain radioactive material inside the reactor building (RB). Refer to FSAR Tier 2, Section 6.2.4, “Containment Isolation System.”

Additionally, FSAR Tier 2, Chapter 16, Technical Specification 5.5.2, “Primary Coolant Sources Outside Containment,” describes a program intended to fulfill the requirements of 10 CFR 50.34(f)(2)(xxvi). The program includes periodic visual inspections for leakage and preventive maintenance on a 24-month interval, and it gives the NSS as an in-scope system. However, FSAR Tier 2, Technical Specification 5.5.2 did not list the SASS as in-scope, and also did not specifically reference 10 CFR 50.34(f)(2)(xxvi) as a basis.

In RAI 237, Question 09.03.02-16, the staff requested that the applicant provide additional information to comply with 10 CFR 50.34(f)(2)(xxvi). With respect to the PSS, the RAI 237, Question 09.03.02-16 requested a description of the design provisions to comply with 10 CFR 50.34(f)(2)(xxvi). Specifically, the staff requested a more detailed description of the “proper equipment” mentioned in FSAR Tier 2, Section 9.3.2.3 and whether the RB sump level alarm is credited for leakage detection. The staff also requested that the applicant provide a clarification of FSAR Tier 2, Technical Specification 5.5.2 to list the specific in-scope systems and confirm that the technical specification is intended to fulfill the requirements of 10 CFR 50.34(f)(2)(xxvi), and provide the initial test program information.

In an August 12, 2009, response to RAI 237, Question 09.03.02-16, the applicant indicated that:

- The sump level indication is too gross to meet 10 CFR 50.34(f)(2)(xxvi) leakage reduction goals, but can detect catastrophic failure of a line. The primary means of detecting and minimizing leakage would be through the program described in FSAR Tier 2, Technical Specification 5.5.2.

- For the NSS, design features that minimize leakage include:

    - Cooling and depressurization of samples as close to containment as possible

    - Using the smallest practicable line size for the sample lines

- Routing of highly radioactive samples back to the CTS or NIDVS sump

- For the SASS, the design features that minimize leakage include:
  - Locating process modules as close as practicable to containment
  - Using glove boxes at the sampling stations
  - Using the smallest practicable line size for the sample lines for the primary liquid samples
  - Returning unused portions and purge flow of primary liquid samples to containment
  - Diluting gaseous samples by the gas sampling module

The staff concludes that the design features provided are acceptable to minimize leakage.

The applicant provided a proposed markup of FSAR Tier , Technical Specification 5.5.2 including the NSS and SASS among the in-scope systems, and provided a proposed markup of FSAR Tier 2, Section 14.2.12.12.7, "Reserved (Test No. 153)," including the initial test program information for the systems subject to 10 CFR 50.34(f)(2)(xxvi), including the NSS and SASS. The initial test program information included an acceptance criterion, which is that the systems are essentially leak tight at normal operating pressure and temperature. If leaks are observed, repairs are made.

Since, for the PSS, the applicant has provided for leakage control and detection in the design of systems outside containment that contain (or might contain) accident source term radioactive materials following an accident (specifically, the NSS and SASS subsystems), and submitted a leakage control program, including an initial test program, a schedule for retesting these systems, and the actions taken for minimizing leakage from such systems, as required by 10 CFR 50.34(f)(2)(xxvi), the staff finds the applicant's response to RAI 237, Question 09.03.02-16 acceptable for the CVCS system. The staff will confirm that the proposed revisions to Technical Specifications 5.5.2 and FSAR Tier 2, Section 14.2.12.12.7 are incorporated into a future revision of the FSAR. The staff has confirmed that these changes has been incorporated in Revision 2 of the FSAR and therefore considers RAI 237, Question 09.03.02-16 resolved**.**

GDC 60 and GDC 63

The design and location of the sample sink and sampling instruments for the SASS follow the guidance of GDC 60 and GDC 63 in that they minimize exposure to plant personnel by locating the sampling equipment in a well shielded location and minimize the size of the sampling lines so that the transport of radioactivity to personnel is minimized. In RAI 113, Question 09.03.02-8 the staff requested that the applicant:

1. Verify that the PSS sampling stations have been designed to ensure that doses to personnel who must operate, service, or inspect these sampling stations will be ALARA by describing some of the ALARA design features (e.g., radiation shielding and other ALARA features described in NRC Regulatory Guides – Occupational Health (Division 8)), RG 8.8, incorporated into these sample stations to minimize personnel doses and minimize contamination.

2. Describe some of the design features of the PSS sampling stations that will minimize contamination of the facility during the taking of samples, in accordance with the requirements of 10 CFR 20.1406.

3. The description of the secondary sampling system in FSAR Tier 2, Section 9.3.2.2.1.2, “Secondary Sampling System,” states that the steam generator blowdown system (SGBS) recycles samples upstream of its system processing equipment to allow regular treatment. However, the FSAR also states that “if the SGBS is unavailable, the liquids are directed to the drain and vent sump.” The staff requested that the applicant provide more detail on which drain and vent sump will be used for disposal and how this disposal method will minimize contamination in accordance with 10 CFR 20.1406.

4. FSAR Tier 2, Section 9.3.2.2.3, “System Operation,” states that local sample stations will be provided for the demineralized water storage tank, circulating water cooling water basin make up, and the closed cooling water system. Past operating experience has shown that non radioactive systems, such as the three mentioned above, can become contaminated with low levels of radioactivity due to leakage, valving errors or other operating conditions in radioactive systems. For example, the demineralized distribution system description provided in FSAR Tier 2, Section 9.2.7, “Seal Water Supply System,” states that the seal water system pumps take suction from the demineralized water tanks which are located outside. Since the seal water system interfaces with systems containing radioactive liquids, there is a potential for the demineralized water storage tank to become contaminated, such as through check valve leakage.

    a. 10 CFR 20.1406, “Minimization of Contamination,” requires, in part, that all COL and design certification applicants describe plans to minimize, to the extent practicable, the contamination of the facility, the contamination of the environment, and the generation of radioactive waste. Therefore, the staff requested that the applicant provide information on what provisions will be in place to contain any spills or leakage at the three sampling stations mentioned above in accordance with 10 CFR 20.1406.

    b. It is not clear to the staff what the purpose of the closed cooling water system is. Therefore, describe the function of the closed cooling water system, or provide a reference to the section of the FSAR where a description is provided.

In a February 27, 2009, response to RAI 113, Question 09.03.02-8, the applicant described the use of sample (glove) boxes operating at sub-atmospheric pressure to minimize airborne radioactivity releases to the environment during the sampling procedure. In addition, FSAR Tier 2, Section 12.3.1.9.2, “Equipment Design Features,” states that shielding will be provided at local sample stations as required to minimize personnel exposure during sampling. Furthermore, data obtained from their sampling functions provides information so that operators can initiate proper safety actions should radioactivity levels increase during normal or accident conditions. The staff concludes that the SASS complies with the requirements of GDC 60 and GDC 63. The staff notes that provisions have been made for the flushing of the sampling lines with demineralized water, fire protection water, or nitrogen gas. The flushing of these lines can be made either to their respective sample points or the radwaste handling system.

Except for open item in RAI 185, Question 09.03.02-11, the staff concludes that the SASS complies with GDC 60, GDC 63, GDC 64; and 10 CFR 50.34(f)(2)(xxvi).

Hydrogen Monitoring System

The HMS is reviewed in Section 6.2.5 of this report.

10 CFR 20.1101 (b) and 10 CFR 20.1406

10 CFR 20.1101 (b) states, in part, that the licensee shall use procedures and engineering controls based on sound radiation protection principles to achieve occupational doses that are ALARA. In FSAR Tier 2, Section 9.3.2, the applicant states that ALARA is considered in station layout and design and provides a description of several design features including: the use of sample (glove) boxes in the NSS, degassing one sample stream at a time, passive flow restrictions which limit the radiation source to which a worker would be exposed, and flushing of lines to minimize the buildup of crud in sample lines.

Furthermore, in a February 27, 2009, response to RAI 113, Question 09.03.02–8 and in a July 6, 2009, response to RAI 217, Question 09.03.02-13, the applicant proposed a revision to FSAR Tier 2, Section 9.3.2.2.1.1, “Nuclear Sampling Station,” to include information on the shielding present at the NSS primary sample station. The U.S. EPR design shields the primary sample station by locating it in the room next door to the major local radiation source: The NSS recycle collection tank. The two rooms have no shared entry points. Occupational exposures are reduced by the presence of the shield wall, as well as the minimal piping distance that primary samples must travel to reach the recycle tank. The staff reviewed the shielding diagrams in FSAR Tier 2, Section 12.3, “Radiation Protection Design Features,” and confirmed the presence of the shield wall for the primary sampling station. The PSS shielding and source term reduction design features described in the applicant’s July 6, 2009, response to RAI 217, Question 09.03.02-13, are based on the guidance of RG 8.8 and, therefore, the staff finds acceptable. The staff confirmed that the proposed revisions to FSAR Tier 2, Section 9.3.2.2.1.1, “Nuclear Sampling System,” are incorporated into the FSAR. Accordingly, the staff finds RAI 217, Question 09.03.02-13, Parts a, c, and resolved.

In a July 6, 2009, response to RAI 217, Question 09.03.02-13, concerning contamination control and build up of crud in sample lines during sampling, the applicant stated that the deposition of crud is minimized through sample velocity, short delay times, flushing, sloping of sample lines, avoiding stagnant legs, and providing low point drains.

The applicant also indicated in the July 6, 2009, response to RAI 217, Question 09.03.02-13, that it would conform to the guidance in the EPRI Secondary Water Chemistry Guidelines for the design of sample lines ensuring that line splits avoided non-homogenous flow splitting of two phase samples by using tees rather than right angle intersects. The staff finds the applicant’s response to RAI 217, Question 09.03.02-13, Part b acceptable.

The requirements of 10 CFR 20.1406(b) state, in part, that each design certification applicant shall describe their plans to minimize, to the extent practicable, the contamination of the facility and the environment, as well as the generation of radioactive waste. Applicants are also required to describe their plans to facilitate decommissioning. RG 4.21 contains guidance acceptable to the staff for complying with the requirements of 10 CFR 20.1406. Where the applicant adhered to the guidance, the staff can have reasonable assurance of that the applicant has complied with 10 CFR 20.1406. In a February 27, 2009, response to RAI 113, Question 09.03.02-8, the applicant identified aspects of the PSS design which minimize facility contamination in accordance with 10 CFR 20.1406. These include recycling to the originating system or disposing of any samples as radioactive waste, directing steam generator blow down sampling system drainage to the NIDVS during system unavailability, and minimizing the use of embedded PSS piping. The staff confirmed that these design features, as described above, are consistent with the guidance of RG 4.21, and are therefore acceptable.

The staff finds the provisions identified in the applicant's February 27, 2009, response to RAI 113, Question 09.03.02–8, as supplemented by the applicant's July 6, 2009, response to RAI 217, Question 09.03.02-13, acceptable since the responses are consistent with the guidance of RG 8.8 and RG 4.21 and, therefore, comply with 10 CFR 20.1101(b) to keep radiation exposures at ALARA levels, and comply with 10 CFR 20.1406 for minimization of contamination. Therefore, except for RAI 217, Question 09.03.02-13, the staff concludes that, the PSS complies with 10 CFR 20.1101(b) and 10 CFR 20.1406. Therefore, the staff considers RAI 113, Question 09.03.02-8 and RAI 217, Question 09.03.02-13 resolved.

Technical Specifications and Surveillance

SRP Section 9.3.2 recommends that the plant Technical Specifications include the required analysis and frequencies.

No technical specifications or surveillance requirements (SRs) relate directly to the PSS. However, the NSS is needed to perform the following SRs:

- SR 3.4.15.1, which verifies reactor coolant dose equivalent XE-133 specific activity
- SR 3.4.15.2, which verifies reactor coolant dose equivalent I-131 specific activity
- SR 3.5.1.4, which verifies boron concentration in each accumulator
- SR 3.5.1.6, which verifies the isotopic concentration of ^{10}B in each accumulator
- SR 3.7.15.1, which verifies that the spent fuel storage pool boron concentration is within limit
- SR 3.7.15.2, which verifies that the isotopic concentration of ^{10}B in the spent fuel storage pool is within limit

The SECSS is needed to perform the following SR:

- SR 3.7.17, which verifies the activity of the secondary coolant for DEI-131

These technical specification samples can be obtained with the sampling systems identified in FSAR Tier 2, Section 9.3.2. Thus, the FSAR provides designs for these systems to conform to the sampling specifications and comply with GDC 13, GDC 14, and GDC 29.

No additional Technical Specification items were identified as being necessary.

ITAAC

FSAR Tier 2, Table 14.3-2, "Radiological Analysis (Safety-Significant Features)," Item 2-2 identifies the integrated leak rate testing requirements for L_a as 0.25 percent. This test is performed with all lines into containment isolated; these include the NSS and the SASS lines. The table references the testing to FSAR Tier 2, Section 6.2.6.3, "Containment Isolation Valve Leakage Rate Test (Type C)."

FSAR Tier 2, Section 6.2.6.3 identifies the testing requirements for monitoring the RCS leakage through control intercept valves identified in FSAR Tier 2, Table 6.2.4-1. The valves identified in this section are consistent with the guidance of NUREG-0737, Section III.D.1.1 and comply with the requirements of 10 CFR 50.34(f)(2)(xxvi) for initial and continued monitoring of RCS leak rate through the NSS lines and valves.

Preoperational Testing

Preoperational testing of the NSS is detailed in FSAR Tier 2, Section 14.2.12.9.10, and, “Nuclear Sampling System (Test No. 100) Preoperational,” testing of the SECSS is detailed in FSAR Tier 2, Section 14.2.12.7.13, “Secondary Sampling System (Test #071).”

FSAR Tier 2, Sections 14.2.12.1, “NSSS Support Systems,” to 14.2.12.1.11, “Coolant Purification System (Test #11),” describe tests of pressure and flow of the CVCS components that are sampled by the NSS. None of these tests involve measuring the chemistry performance of the resins, filters, or representative sampling. Such parameters are based on commercial properties of the purchased resins and filters and basic engineering design of the CVCS and NSS systems. No additional preoperational tests of chemical performance are necessary.

10 CFR Part 50, Appendix A, GDC 64, requires that fission product gases be sampled and analyzed under all plant operating conditions. RG 1.68, Appendix A.I.8, states that appropriate tests should be conducted to demonstrate the functional operability and design flow rates of plant sampling systems during the initial test program. FSAR Tier 2, Section 14.2.12.9.10, “Nuclear Sampling System (Test #100),” tests the nuclear sampling system; however, the SASS, which is a similar auxiliary system, is not being tested. Therefore, In RAI 98, Question 14.02-47 the staff requested that the applicant add a test abstract for the preoperational testing of the SASS or provide justification for not performing preoperational testing of the SASS. No preoperational testing of the SASS was identified. In a November 14, 2008, response to RAI 98, Question 14.02-47, the applicant proposed revising FSAR Tier 2, Section 14.2.12.9.10 to include testing of the SASS. The staff confirmed that Revision 1 of the FSAR, dated May 29, 2009, contains the changes committed to in the RAI response acceptable. Accordingly, the staff finds the applicant has adequately addressed this issue and, therefore, considers RAI 98, Question 14.02-47 resolved.

In RAI 237, Question 09.03.02-16, the staff requested that the applicant clarify the following:

1. Other than Residual Heat Removal System (RHR), Emergency Core Cooling System (ECCS), PSS, and CVCS, identify any other systems in scope of 10 CFR 50.34(f)(2)(xxvi). If any systems expected to contain radioactive materials after an accident are excluded from the leakage detection program, justify the exclusion of these systems.

2. For the PSS, describe the design provisions that facilitate minimization and detection of leakage for each of the systems in accordance with 10 CFR 50.34(f)(2)(xxvi). Specifically, describe the “proper equipment” mentioned in FSAR Tier 2, Section 9.3.2.3 in more detail. Confirm that the PSS credits the Safeguard Building sump level indication as in the case of the CVCS system.

3. For those systems that credit building sump level indication/alarms for leakage detection, describe the identification process for the location of the specific leakage.

4. Discuss the need to include a COL information item in the FSAR to ensure the COL applicant develops a program for leakage monitoring and prevention to fulfill the requirements of 10 CFR 50.34(f)(2)(xxvi).

5. Clarify whether proposed Technical Specification 5.5.2 is intended to fulfill the requirements of 10 CFR 50.34(f)(2)(xxvi). If so, these criteria should be referenced in the technical specification.

6. In FSAR Tier 1 and Tier 2, provide the initial test program information for leakage control and detection for all systems outside containment that contain (or might contain) accident source term radioactive materials following an accident.

In an August 12, 2009, response to RAI 237 Question 09.03.02-16, the applicant provided a markup of FSAR Tier 2, Section 14.2.12.12.7 (Test No. 153) providing the initial test program information for the systems subject to 10 CFR 50.34(f)(2)(xxvi), including the NSS and SASS (see discussion of SASS subsystem for more details). The staff will confirm that the proposed revisions to FSAR Tier 2, Section 14.2.12.12.7 are incorporated into a future revision of the FSAR. The Staff has confirmed that the change has been incorporated in Revision 2 of the FSAR and therefore considers RAI 237, Question 09.03.02-16 resolved.

No additional COL information items are recommended.

9.3.2.5 *Combined License Information Items*

There are no COL information items from FSAR Tier 2, Table 1.8-2 that affect this section.

9.3.2.6 *Conclusions*

The PSS and its components, NSS, SECSS, and SASS, identify sampling locations within the RCS and associated systems so that chemical contaminants concentrations may be monitored and radioactivity measurements made and assessed to enable plant operators to take actions that minimize exposure to workers and limit offsite doses.

The HMS is evaluated in Section 6.2.5 of this report.

Except for open items noted in Section 9.3.2.4 above, the staff finds that the PSS complies with GDC 1, GDC 2, GDC 13, GDC 14, GDC 26, GDC 41, GDC 60, GDC 63, GDC 64 and complies with the guidance in NUREG-0800, Section 9.3.2. The staff's review of the FSAR Tier 2 sections indicate that the NSS, SECSS, and SASS designs and sampling functions are acceptable for normal and severe accident conditions as described in the FSAR, and they meet regulatory requirements that address satisfactory design testing of these systems. The PSS identifies the sampling points given in the NUREG-0800.

The ITAAC, Technical Specifications, and COL information items were reviewed by the staff with respect to monitoring functions of each of these systems. FSAR Tier 2, Chapter 16, Technical Specifications 3.4.15, 3.7.17, 3.5.1.4, and 3.5.1.6 are satisfied by the sampling systems noted. Except for the open items and confirmatory items noted above, the staff finds the sampling systems comply with 10 CFR 20.1101 and are consistent with the guidance in NUREG-0800, Section 9.3.2.

9.3.3 Equipment and Floor Drainage System

9.3.3.1 *Introduction*

The NIDVS is designed to collect, store, and discharge potentially radioactive liquid and gaseous effluents to the proper areas for processing or disposal in a controlled manner.

The system also evacuates potentially radioactive gases in the reactor coolant system. The NIDVS supports reactor coolant pressure boundary leakage detection through safety-related sump instrumentation. In a safeguards building flooding event, the NIDVS trips the essential service water system (ESWS) pump and closes the ESWS pump discharge valve.

9.3.3.2 *Summary of Application*

FSAR Tier 1: The NIDVS is addressed in FSAR Tier 1, Revision 2, Section 2.9.5, "Nuclear Island Drain and Vent System." FSAR Tier 1, Table 2.9.5-1, "NIDVS Equipment I&C and Electrical Design," provides a summary of the NIDVS instrumentation and controls (I&C) and electrical design.

FSAR Tier 2: The NIDVS is described in Tier 2, Section 9.3.3, "Equipment and Floor Drainage System," and Figure 9.3.3-1, "Nuclear Island Drain and Vent System."

ITAAC: Inspections, tests, analyses, and acceptance criteria for the NIDVS are included in FSAR Tier 1, Table 2.9.5-2, "Nuclear Island Drain and Vent System ITAAC."

Technical Specifications: There are no technical specifications associated with the NIDVS.

9.3.3.3 *Regulatory Basis*

The relevant regulatory requirements for this area of review, and the associated acceptance criteria, are listed in NUREG-0800, Section 9.3.3, "Equipment and Floor Drainage System," Revision 3, March 2007, and are summarized below. Review interfaces with other Standard Review Plan sections can be found in NUREG-0800, Section 9.3.3.

1. GDC 2, as it relates to safety-related system portions capable of withstanding the effects of natural phenomena such as earthquakes, tornadoes, hurricanes and floods without loss of safety-related functions.

2. GDC 4, as it relates to the effects of missiles inside and outside of containment, pipe whip, jets, and environmental conditions from high and moderate energy line breaks and dynamic effects of flow instabilities and loads (e.g., water hammer) during normal plant operation, as well as during accident conditions.

3. GDC 60, as it relates to suitable control of the release of radioactive materials in liquid effluent, including anticipated operational occurrences. This criterion applies, as the equipment and floor drainage system (EFDS) usually consists of two subsystems, radioactive and non-radioactive. The inadvertent transfer of radioactive wastes to the non-radioactive portion of the system could result in radioactive releases to the environment.

4. 10 CFR 52.47(b)(1), which requires that a design certification application contain the proposed ITAAC that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests and analyses are performed and the acceptance criteria met, a plant that incorporates the design certification is built and will operate in accordance with the design certification, the provisions of the Atomic Energy Act of 1954 and NRC regulations.

5. 10 CFR 20.1406, "Minimization of contamination," as it relates to the design features that will facilitate eventual decommissioning and minimize, to the extent practicable, the

contamination of the facility and the environment and the generation of radioactive waste.

9.3.3.4 *Technical Evaluation*

The staff reviewed the NIDVS described in FSAR Tier 2, Revision 2, in accordance with NUREG-0800, Section 9.3.3 “Equipment and Floor Drainage System, Revision 3, March 2007.

GDC 2

GDC 2 acceptance is based on the safety-related portions of the system being able to withstand the effect of natural phenomena (such as seismic event).

FSAR Tier 2, Section 9.3.3.3, “Safety Evaluation,” identifies the safety-related portions of the NIDVS being containment isolation valves, piping, and penetrations. It also states that the safety-related portions of the NIDVS comply with GDC 2, withstanding the effect of natural phenomena as demonstrated by the following design features:

- Safety-related portions of the NIDVS are located in the RB and fuel building (FB). These buildings are designed to withstand the effects of earthquakes, tornados, hurricanes, floods, tsunami, and seiches.

- Safety-related portions of the NIDVS are designed as Seismic Category I.

- Safety-related portions of the NIDVS are protected against the effects of flooding by consideration of the following design features: redundancy, location, and physical separation.

The staff reviewed the above information and confirmed in FSAR Tier 2, Table 6.2.4-1, “Containment Isolation Valve and Actuator Data,” (Sheet 12 of 18) and FSAR Tier 2. Table 3.2.2-1, “Classification Summary,” (Sheet 112) that the NIDVS CIVs and piping are designed as safety-related and Seismic Category I. Therefore, the staff finds that the safety-related portions of the NIDVS, as identified in the by the applicant, are designed to conform to the guidance in RG 1.29, “Seismic Design Classification,” Regulatory Position C.1, and comply with GDC 2. The containment isolation system is described in FSAR Tier 2, Section 6.2.4, and is evaluated by the staff in Section 6.2.4 of this report. In addition, the containment sump level and discharge flow monitoring functions of the NIDVS is described in FSAR Tier 2, Section 5.2.5 and is evaluated by the staff in Section 5.2.5 of this report.

In addition, the staff reviewed the adequacy of the applicant’s determination of the safety-related portions of the system to determine whether there are other portions of the NIDVS that should be safety-related in accordance with NUREG-0800, Section 9.3.3, Subsection III, “Review Procedures.” NUREG-0800, Section 9.3.3, Subsection III, Procedure 1.D states that if the failure of a portion of the system could affect safety-related SSCs adversely, it is safety-related and, therefore, should comply with the requirements of GDC 2. The staff identified the following portions of the system that may be safety-related and subject to GDC 2 requirements in accordance with RG 1.29, Regulatory Position C.1 and NUREG-0800, Section 9.3.3 review procedures:

- Sump pump level instruments in the Safeguards Building that provide isolation signals for Safeguards Building ESWS train:

Since the NIDVS level sensors detect flooding and are credited for the 30-minute operator response to secure the source of flooding, a failure or malfunction in this portion of the system could adversely affect safety-related SSCs. A false high sump level could inadvertently render ESWS inoperable or a failure to detect a high level in the redundant level sensors could prevent the flood high level isolation of ESWS.

- The level instruments (in RB, Safeguards Building, and FB sumps) that are used to provide the main control room (MCR) flood alarms:

  These flood alarms notify the MCR operator to begin the operator action to isolate the line causing the flooding. The fire water line break defines the worst case flood analysis for the NI buildings (RB, Safeguards Building, and FB). The staff notes that a failure or malfunction in this portion of the system could adversely affect safety-related SSCs. A malfunction could prevent the flood level from remaining below the elevation assumed in the flood analysis.

Since the above components are credited to prevent flooding of safety-related equipment, the failure of the above components could adversely affect safety-related SSCs. Therefore, (in RAI 163, Question 09.03.03-2, the staff requested that the applicant classify these components as being safety-related or to justify the non-safety-related classification.

The applicant's May 7, 2009, response to RAI 163, Question 09.03.03-2, is summarized below.

1. In a February 19, 2009, response to RAI 131, Question 09.02.01-25, the applicant stated that the NIDVS sump level instrumentation, located at the lowest level in the non-controlled areas of the Safeguards Building will be upgraded to safety-related, Seismic Category I. This level instrumentation provides a signal to automatically isolate the ESWS train in the affected Safeguards Building during a flooding event. The applicant indicated that FSAR Tier 2, Sections 9.3.3.3 and 9.3.3.5 will be revised to further clarify the classification of this NIDVS sump level instrumentation.

2. The following NIDVS sumps have safety-related, Seismic Category I level instrumentation that annunciates in the MCR to notify operators of a flooding event, and to initiate operator action to isolate the worst-case flooding source (the fire water distribution system):

   - RB sump (1)
   - RB annular space sump (1)
   - Safeguards Building sumps (4)
   - FB sumps (2)

The applicant also stated that FSAR Tier 2, Sections 3.4.3.3 and 3.4.3.5 will be revised to further clarify the classification of these NIDVS sump level instrumentation. In a July 14, 2011, response to RAI 163, Question 09.03.03-5, the applicant proposed to add classification information for the safety-related level instrumentation into FSAR Tier 2, Table 3.2.2-1, which is discussed in RAI 163, Question 9.3.3-5 of this report.

The staff concludes that the changes proposed by the applicant to upgrade the sump level instrumentation that annunciates in the MCR to be safety-related. The staff also concluded that

Seismic Category I to be partially acceptable because it conforms to portions of RG 1.29 regulatory positions for complying with GDC 2, such as being safety-related. However, it is unclear to the staff what redundancies are built into the design of the level instrumentation to ensure that the instruments can meet single failure criteria while providing adequate protection. In addition, it is unclear to the staff whether the Safeguards Building sump level instrumentation is located inside the actual Safeguards Building sump or above the Safeguards Building floor level as described in FSAR Tier 2, Section 3.4.3.4. Finally, NUREG-0800, Section 9.3.3, Procedure III.3.A states that if any non-safety-related SSCs failure could adversely impact any safety-related SSC from performing its safety function, then either the non-safety- related SSC has to be designed to Seismic Category I, or the safety-related SSC has to be protected from the failure of the non-safety-related SSC. The staff is unable to locate any confirmation that any of the remaining non-safety-related portions failure will not adversely affect any safety-related portions of the NIDVS. The staff requested that the applicant provide justification that if any non-safety-related SSCs fail, they will not adversely impact safety-related SSCs. In RAI 476, Question 09.03.03-7, the staff requested that the applicant clarify the differences between non-safety-related and safety-related portions of the system. Additionally, in RAI 476, Question 09.03.03-9, the staff requested that the applicant specify the “redundancy, location, and physical separation” being credited in the FSAR in order to comply with GDC 2. **RAI 476, Questions 09.03.03-7 and 09.03.03-9 are being tracked as open items.**

GDC 4

GDC 4 acceptance is based on the system being able to prevent flooding that could adversely affect SSCs important to safety. NUREG-0800, Section 9.3.3, Subsection II, “Acceptance Criteria,” Technical Rationale Number 2 clarifies the acceptance of GDC 4 for the NIDVS. It states that the purpose of GDC 4 is to assure the capability of the NIDVS to provide the necessary drainage capability to accommodate unanticipated flooding from pipe breaks, tank leaks, discharge from fire suppression systems, and other potential flooding sources. Therefore, the staff concluded that the drainage capability of the NIDVS for flood protection should be addressed in the FSAR for NIDVS to comply with the requirements of GDC 4.

FSAR Tier 2, Section 9.3.3.3, “Safety Evaluation,” states that the design of safety-related portions of the NIDVS comply with GDC 4 by withstanding the effects of the environmental conditions (e.g., flooding) as demonstrated by the design features described in the section. The staff reviewed the above statement and the design features described in FSAR Tier 2, Section 9.3.3.3, and determined that the applicant does not credit the NIDVS drainage capability in its flooding analysis. Furthermore, the staff determined that FSAR Tier 2, Section 3.4.1, “Internal Flood Protection,” stated that the NIDVS is conservatively considered not available for reducing water volume by the respective sump pumps. The staff verified whether this assumption had been applied consistently in the flood analyses and design bases. In FSAR Tier 2 Table 3.2.2-1, the staff confirmed that the sump pumps are not safety related. Therefore, pumps could be unavailable following a seismic event. FSAR Tier 2, Section 9.3.3 states: “The flooding analysis assumes the NIDVS floor drains are plugged and the sump pumps are not available for water volume reduction during a flooding event.”

The staff concludes that floor drains are not credited in the flooding analysis for protecting safety-related SSCs that are required for safe shutdown and find this acceptable because the applicant clarified the function of the floor drains to be consistent in FSAR Tier 2, Sections 3.4.1, 3.4.3.1, 3.4.3.4 and 9.3.3.3. The detailed flooding analysis is evaluated by the staff in Section 3.4.1 of this report.

The staff reviewed the NIDVS check valves that prevent backflow of flooding water through the drain system into areas of the plant containing safety-related equipment. NIDVS piping between the two divisions of the FB and between Safeguard Buildings SB-1, SB-2, SB-3, and SB-4 relies upon double check valves to prevent back flow. The NIDVS piping in the nuclear auxiliary building (NAB) connects to safety-related equipment areas of the FB and Safeguards Building. Following the review procedures described in NUREG-0800, Section 9.3.3, Subsection III.1 and RG 1.29, Regulatory Position C.2, the staff determined that failure of these non-safety-related piping and check valves could affect the flood protection of safety-related SSCs. Therefore, the safety significance of these piping and check valves may justify increased attention to their reliability and ability to function following a seismic event. Therefore, in RAI 163, Question 09.03.03-4, the staff requested that the applicant clarify the ability of these non-safety-related piping and check valves to function following a seismic event, and the requirements for testing and inspection of these components to ensure the reliability of these components to be able to perform their intended function for flood protection.

In a May 7, 2009, response to RAI 163, Question 09.03.03-4, the revised the individual sump pump discharge line routings and revised the FSAR figures as follows:

> Pump discharge lines from the NIDVS in each of the Safeguards Building, as well as the sumps from the Fuel Building (FB), are individually routed to their destination in the Nuclear Auxiliary Building (NAB). As a result, failure of a check valve in any of these discharge lines does not provide an opportunity for backflow from one sump discharge into another. In addition, the collection tank in the NAB has separate nozzles for each incoming line, and an air gap provides further protection against backflow to the sumps.

The staff confirmed that FSAR Tier 2, Revision 2, Section 9.3.3.2.3 has been revised to state that sump pump discharge lines in each of the Safeguards Buildings and FB are routed individually to their destination. FSAR Tier 2, Figure 9.3.3-1, “Nuclear Island Drain and Vent System,” has also been revised to show the piping layout. The individual routing of the NIDVS pump discharge lines from Safeguards Building and FB to the NAB provide protection against one division adversely affecting another division in the event of backflow of flooding water. The staff finds the proposed changes acceptable because they comply with GDC 4 according to NUREG-0800, Section 9.3.3 and RG 1.29, Regulatory Positions C.1 and C.2. Therefore, the staff considers RAI 163, Question 09.03.03-4 resolved.

In reviewing the potential blockage of the NIDVS in accordance with NUREG-0800, Section 9.3.3, Review Procedure (III.1.B), the staff notes that FSAR Tier 2, Section 5.2.5.4 states that periodic testing of the floor draining system will verify that it is free of blockage. The staff considers this periodic testing acceptable for addressing the potential blockage concern. However, FSAR Tier 2, Section 5.2.5.4 testing is for the floor drain for RCPB leakage detection only. The staff does not consider a testing requirement for the other floor drains since they are not credited in the flooding analysis for protecting safety-related SSCs that are required for safe shutdown.

In summary, based on the preceding discussion, the staff concludes that the NIDVS complies with the requirements of GDC 4. The NIDVS is adequately protected from dynamic effects due to equipment failures and external environmental conditions and is capable of performing its safety functions over the entire range of environmental conditions that are possible.

GDC 60

GDC 60 requires suitable control of the release of radioactive materials in liquid effluent. FSAR Tier 2, Section 9.3.3.3 states that the NIDVS is designed to prevent the inadvertent transfer of contaminated fluids to non-contaminated drainage systems. There is physical separation between systems that may contain radioactive effluents and systems that do not contain radioactive effluents. System design and operational controls monitor the transfer of effluents to the appropriate treatment systems.

The staff reviewed FSAR Tier 2, Section 9.3.3, the NIDVS diagrams (Figure 9.3.3-1, Sheets 1 through 8) and building areas, and confirmed that there is physical separation between areas of the system piping and sumps that may contain radioactive effluents and areas of system piping and sumps that do not contain radioactive effluents. In addition, in FSAR Tier 2, Sections 12.3.1.9.2 and 12.3.6.2, the staff notes that the NIDVS's potential for introducing radioactive effluents into the environment is minimized by installing barriers, by utilizing leak detection equipment, and by constructing sumps with nonporous materials that are double lined and recessed into concrete floors. The NIDVS transfers effluent to the radioactive waste processing building for processing. The liquid waste management system described in FSAR Tier 2, Section 11.2 is designed to monitor, control, collect, process, store, and dispose of liquid radioactive waste generated as the result of normal plant operations and abnormal operational occurrences. The staff notes that this ensures that radioactive material cannot be discharged by the NIDVS. Effluent is sampled for radiation prior to discharge by the liquid waste management system.

However, NUREG-0800, Section 9.3.3 encompasses all drains in the plant and the applicant only discussed drains for the nuclear island. Therefore, in RAI 476, Question 09.03.03-9, the staff requested that the applicant provide additional information regarding drains outside the Nuclear Island. The staff also requested that the applicant provide information regarding drains outside the NIDVS and clarify if those drains have any impact on NIDVS. Additionally, the staff requested that the applicant justify the absence of these drains from FSAR Tier 2, Section 14.2 testing (test abstract #098). **RAI 476, Question 09.03.03-9 is being tracked as an open item.**

10 CFR 20.1406

The staff evaluation of NIDVS compliance with 10 CFR 20.1406 is discussed in Chapter 12, "Radiation Protection," of this report.

The staff also identified an RAI question during review of the February 27, 2009, response to RAI 113, Question 09.03.02-8. RAI 113, Question 09.03.02-28 dealt with ALARA aspects of the process sampling system. The specific follow up question concerned the routing of the steam generator blowdown sample flow to the NIDVS. Part 3 of RAI 113, Question 09.03.02-8 requested that the applicant provide additional information on the description of the flow of steam generator blowdown sampling system fluids when the blowdown system was unavailable to have the sample flow reprocessed. In the February 27, 2009, response to RAI 113, Question 09.03.02-8, the applicant stated that the sample flow would be directed to the NIDVS and processed by the plant waste liquid system. Based on current sampling frequency and analysis requirements for steam generator blowdown in the EPRI Secondary Water Chemistry Guidelines, each steam generator will likely need at least 7.57 liters per minute (l/min)) (2 gallons per minute (gpm) of flow in order to maintain appropriate monitoring of steam generator chemistry. Therefore, in RAI 476, Question 09.03.03-8, the staff requested that the applicant describe how the design of the NIDVS sump will receive this process flow and be able to adequately handle this input, as well as other inputs to the sump, without exceeding its capacity for volume or flow. **RAI 476, Question 09.03.03-8 is being tracked as an open item.**

ITAAC

10 CFR 52.47(b)(1) requires that a design certification application contain the proposed ITAAC that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a plant that incorporates the design certification is built and will operate in accordance with the design certification, the provisions of the Atomic Energy Act of 1954, and NRC regulations. FSAR Tier 2, Section 9.3.3 states that the NIDVS meets GDC 2, GDC 4, and GDC 60. NUREG-0800, Section 9.3.3 Acceptance Criteria 4 specifies that ITAAC should be provided to verify the plant is built in accordance with the design certification.

FSAR Tier 1, Section 2.9.5, describes the NIDVS and identifies the ITAAC associated with the system. FSAR Tier 1, Table 2.9.5-1, "NIDVS Equipment I&C and Electrical Design" and FSAR Tier 1, Table 2.9.5-2 incorporate the safety function of the sump level instrumentation into Tier 1 (including main control room alarms and ESWS interfaces), and provide corresponding ITAAC. In RAI 476, Questions 09.03.03-7 and 09.03.03-9, the staff requested that the applicant clarify the redundancy, location, and physical separation of these level detectors and ensure that there is reasonable assurance that they will perform their safety function. **RAI 476, Questions 09.03.03-7 and 09.03.03-9 are being tracked as open items.** The NIDVS containment isolation valves are described in FSAR Tier 2, Sections 6.2.4 and 7.3, and along with associated ITAAC for those valves in corresponding Tier 1 sections.

Initial Testing Program

Applicants for standard plant design approval must provide plans for preoperational testing and initial operations in accordance with 10 CFR 50.34(b)(6)(iii) requirements. FSAR Tier 2, Section 14.2.12.9.8, "Equipment and Floor Drainage System (Test #098)," verifies the proper operations of the NIDVS. FSAR Tier 2, Section 14.2.12.9.6, "Reactor Coolant Drain Tank (Test #096)," verifies the proper performance of the reactor coolant drain tank subsystem. FSAR Tier 2, Section 14.2.12.9.7, "Equipment Drain Tank (Test #097)," verifies the proper performance of the equipment drain tank (EDT) subsystem. The initial test program for U.S. EPR is evaluated in Section 14.2 of this report, and evaluation of the NIDVS initial test program in this section is an extension of the evaluation provided in Section 14.2. The staff finds the objectives of the NIDVS, RCDT, and EDT initial test programs appropriate, since it demonstrates the NIDVS is operating as described in FSAR Tier 2, Section 9.3.3.

Plant Technical Specifications

There are no U.S. EPR Technical Specification sections for the NIDVS. This is consistent with SRP Section 16, NUREG-1431, "Standard Technical Specifications for Westinghouse Plants," and is acceptable to the staff.

9.3.3.5 *Combined License Information Items*

The FSAR does not identify any combined license information items for the NIDVS. The staff considers this acceptable.

9.3.3.6 *Conclusions*

The staff evaluated the NIDVS for the U.S. EPR standard plant design in accordance with the guidance that is referred to in the Regulatory Basis Section 9.3.3.3 of this report. The staff's review included information in the FSAR as supplemented by the applicant's response to numerous RAIs, which have been incorporated in FSAR Revision 2 used for this report. The staff will update this SE with respect to compliance with Part 20.1406 during Phase 4 review. **RAI 520, Questions 09.03.03-10 was created to track this action as an open item.**

The staff reviewed the U.S. EPR application in accordance with NUREG-0800, Section 9.3.3, "Equipment and Floor Drain System." Except for the four open items discussed above, the staff concludes that the U.S. EPR equipment and floor drain system is acceptable in accordance with GDC 2, GDC 4, and GDC 60.

9.3.4 Chemical and Volume Control System (Including Boron Recovery System)

9.3.4.1 *Introduction*

The chemical and volume control system (CVCS) maintains the required water inventory and quality in the RCS through its charging and letdown functions, provides flow to the reactor coolant pump seals, and controls the boron neutron absorber concentration in the reactor coolant. The CVCS performs both safety and non-safety-related functions as summarized in Section 9.3.4.2 of this report.

9.3.4.2 *Summary of Application*

FSAR Tier 1: The Tier 1 information associated with this section is found in Tier 1 Section 2.2.6, "Chemical and Volume Control System."

FSAR Tier 2: The applicant has provided a Tier 2 system description in Section 9.3.4, "Chemical and Volume Control System (Including Boron Recovery System)," summarized here, in part, as follows:

The CVCS provides a flow path for the continuous letdown and charging of the RCS. The flow diagrams of the CVCS are shown in Figure 9.3.4-1, "Chemical and Volume Control System"; Figure 9.3.4-2, "Coolant Purification System"; Figure 9.3.4-3, "Coolant Degasification System"; Figure 9.3.4-4, "Reactor Boron and Water Makeup System"; Figure 9.3.4-5, "Coolant Supply and Storage System"; and Figure 9.3.4-6, "Coolant Treatment System." The major system component data is provided in FSAR Tier 2, Table 9.3.4-1, "Major CVCS Component Design Data."

The CVCS performs the following safety-related functions:

- Maintains integrity of RCPB in the event of a CVCS letdown line break by closing the redundant motor-operated isolation valves

- Mitigates boron dilution event by automatically isolating the charging pump suction from the volume control tank (VCT) and normal letdown path, and automatically aligning the charging pump suction to the in-containment refueling water storage tank

- Provides automatic isolation of charging and auxiliary spray line to prevent pressurizer over-fill in the event of a CVCS malfunction

- Provides containment isolation by automatic closure of charging and letdown lines and reactor coolant pump (RCP) seal water injection and return lines

The CVCS also performs the following operational functions:

- Maintains and adjusts the RCS boron concentration to control reactor power level variations resulting from expected reactivity changes due to the effects of xenon build-up or burn-out, and compensate for core burn-up to provide assurance that operating fuel limits are not exceeded

- Maintains RCS water inventory by maintaining a constant charging flow and adjusting the letdown flow to account for volume changes due to RCS temperature variations

- Provides cooled, purified, and filtered water to the RCP seal water system to maintain cooling and leak tightness of the RCP seals and return seal leakage back to the CVCS

- Adds chemicals to the RCS to control the pH of the reactor coolant during all modes of operation; also add hydrogen to the RCS to counteract the production of oxygen in the reactor coolant due to the radiolysis of water in the reactor core region

- Provides an auxiliary spray line to the pressurizer to control reactor coolant pressure in the event the normal spray cannot or is not sufficient to provide the spray function, or when a decrease in RCS pressure is required during cooldown operations

ITAAC: The ITAAC associated with FSAR Tier 2, Section 9.3.4 are given in FSAR Tier 1, Section 2.2.6, Table 2.2.6-3, "CVCS ITAAC."

Technical Specifications: The Technical Specifications associated with FSAR Tier 2, Section 9.3.4 are given in FSAR Tier 2, Chapter 16, and evaluated in Chapter 16 of this report. These include Sections 3.1.8, "Boron Dilution Protection (BDP)," Section 3.9.1, "Boron Concentration," and chemistry related requirements of FSAR Tier 2, Section 3.4.15, "RCS Specific Activity."

9.3.4.3 *Regulatory Basis*

The relevant requirements of the NRC regulations for this area of review, and the associated acceptance criteria, are given in NUREG-0800, Section 9.3.4 and are summarized below. Review interfaces with other SRP sections can also be found in NUREG—0800, Section 9.3.4.

1. 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.

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

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

4. GDC 14, as it relates to assuring reactor coolant pressure boundary material integrity by means of the CVCS being capable of maintaining RCS water chemistry necessary to meet PWR RCS water chemistry technical specifications.

5. GDC 29, as it relates to the reliability of the CVCS to provide negative reactivity to the reactor by supplying borated water to the RCS in the event of anticipated operational occurrences, if the plant design relies on the CVCS to perform the safety function of boration for mitigation of design-basis events.

6. GDC 33 and GDC 35, as they relate to the CVCS capability to supply reactor coolant makeup in the event of small breaks or leaks in the RCPB, to function as part of emergency core cooling system (ECCS) assuming a single active failure coincident with the loss of offsite power, and to meet ECCS technical specifications, if the plant design relies on the CVCS to perform the safety function of safety injection as part of ECCS.

7. GDC 60 and GDC 61, as they relate to CVCS components having provisions for venting and draining through closed systems.

8. 10 CFR 50.34(f)(2)(xxvi), as it relates to the provisions for a leakage detection and control program to minimize the leakage from those portions of the CVCS outside of the containment that contain or may contain radioactive material following an accident.

9. 10 CFR 50.63, Paragraph (a)(2) “Loss of All Alternating Current Power,” as it relates to the ability of the CVCS to provide sufficient capacity and capability to ensure that the core is cooled in the event of a station blackout.

10. 10 CFR 52.47(b)(1), as it relates to the proposed inspections, tests, analyses, and acceptance criteria that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a plant that incorporates the design certification is built and will operate in accordance with the design certification, the provisions of the Atomic Energy Act of 1954, and NRC regulations.

11. 10 CFR 50.34(f)(2)(xxvi), as applicable, specifies the provisions regarding detection of reactor coolant leakage outside containment. These requirements will be met, in part, by providing leakage control and detection systems in the CVCS and implementation of an appropriate leakage control program.

Acceptance criteria adequate to meet some of the above requirements include:

1. The CVCS safety-related functional performance should be maintained in the event of adverse environmental phenomena such as earthquakes, tornadoes, hurricanes, and floods, or in the event of certain pipe breaks or loss of offsite power. For compliance with GDC 29, GDC 33, and GDC 35, the CVCS should provide sufficient pumping capacity to supply borated water to the RCS, maintain RCS water inventory within the allowable pressurizer level range for all normal modes of operation, and function as part of the ECCS, if so designed, to supply reactor coolant makeup in the event of small pipe breaks assuming a single active failure coincident with the loss of offsite power.

2. SECY-77-439 describes the concept of single failure criteria and the application of the single failure criterion that involves a systematic search for potential single failure points and their effects on prescribed missions. Application of the single failure assumption in

system design and analysis provides redundancy and defense-in-depth to ensure functional performance of the CVCS.

3. The CVCS design and arrangement should be that all components and piping that can contain boric acid will either be heat traced or will be located within heated rooms to prevent precipitation of boric acid.

9.3.4.4 *Technical Evaluation*

9.3.4.4.1 Systems Aspects

The CVCS provides the RCS with continuous let-down flow and continuous charging makeup. The system provides both safety-related and non-safety functions. The staff reviewed the applicant's FSAR Tier 1 and Tier 2 information relative to the CVCS in accordance with the guidance of NUREG 0800, Section 9.3.4, “Chemical and Volume Control System (PWR),” Revision 3, dated March 2007. The applicant's FSAR information was compared to the acceptance criteria in NUREG-0800, Section 9.3.4, as described in this evaluation.

The staff notes that that the applicant was referring to the same system as “Reactor Makeup and Inventory Control System,” and the “Reactor Boron and Water Makeup System.” In RAI 125, Question 09.03.04-1, and Question 09.03.04-12, the staff requested that the applicant clarify which is the correct system name and make the appropriate changes to avoid any confusion. In a December 5, 2008, response to RAI 125, Question 09.03.04-1 and Question 09.03.04-12, the applicant clarified that correct designation is “Reactor Boron and Water Makeup System,” (RBWMS). The staff has confirmed that the FSAR has been modified accordingly. FSAR Tier 2, Section 9.3.4.2.1 and FSAR Tier 2, Figure 9.3.4-4, “Reactor Makeup and Inventory Control System,” have been revised to agree with the Kraftwerks Kennzeichen System (KKS) coding for the KBC System. The title of the KBC system listed in FSAR Tier 2, Table 1.7-2, “U.S. EPR System Designators and System Diagrams,” was also changed.

The CVCS maintains water inventory in the RCS using the pressurizer level control system. It also provides RCP seal water injection and auxiliary pressurizer spray. The system is comprised of several subsystems including (1) charging, letdown, and seal water, (2) coolant degasification, (3) RCS chemistry control, (4) RCS makeup and inventory control, and (5) coolant treatment and boron recovery. In this report, the staff’s review addresses the system aspects of the CVCS.

The system performs both safety-related and non-safety-functions. Safety-related functions include maintaining the integrity of the RCS pressure boundary, mitigation of boron dilution events, automatic charging isolation on RCS overfill, and containment isolation of the charging, letdown, and seal water lines.

In FSAR Tier 2 Section 9.3.4.1, the staff notes that the applicant included the automatically alignment of the charging pump suction to the in-containment refueling water storage tank as part of the boron dilution mitigation safety function of the CVCS. However, in FSAR Tier 2, Section 9.3.4.3, the applicant also stated that the CVCS is not designed to perform the safety function of RCS boration for the mitigation of DBEs. In RAI 125, Question 09.03.04-3, the staff requested that the applicant clarify this apparent inconsistency. The staff also requested that the applicant confirm that the safety-related portions of the CVCS reliably provide negative reactivity to the reactor by supplying borated water to the RCS in the event of an anticipated operational occurrence (AOO). The same apparent inconsistency was also found in FSAR Tier 2, Section 9.3.4.2.3.4, “Abnormal Operation.” Therefore in RAI 125, Question 09.03.04-4, the staff requested that the applicant clarify this apparent inconsistency. In a December 5, 2008, response to RAI 125, Question 09.03.04-3 and Question 09.03.04-4, the applicant provided clarification to the CVCS operational function with respect to the boron dilution event as discussed in the paragraph below.

The staff notes that the safety function for mitigating a boron dilution event is completed when the three safety-related motor operated valves that isolate the charging pump suction from the VCT and the normal letdown path are closed. The automatic aligning of the charging pump suction to the IRWST is not a safety function and no credit is taken for it in FSAR Tier 2, Section 15.4.6 events. The CVCS connection to the IRWST is not redundant or single failure proof. The applicant revised FSAR Tier 2, Section 9.3.4.1 to state only the automatic isolation safety function (in FSAR Revision 1), while deleting non-safety-related valve alignment of the pump suction to the IRWST. Similarly, the applicant revised FSAR Tier 2, Section 9.3.4.2.3.4 to state only the automatic isolation safety function (FSAR Revision 1), while clarifying that the pump suction alignment to the IRWST is non-safety-related. The CVCS is not relied on to perform the boration safety function for mitigating design basis events. The EBS or the Safety Injection System (SIS) provides borated water for negative reactivity addition to the reactor coolant system in the event of AOO. The EBS and SIS are safety-related systems that are redundant and single failure proof. The staff considers RAI 125, Question 09.03.04-3 and Question 09.03.04-4 resolved.

The staff notes that non-safety functions include maintenance of RCS boron concentration, RCS water inventory, supplying cooled and filtered water to the RCP seal water system, RCS chemical and radiological control, and pressurizer auxiliary spray as a backup to the normal spray line.

The staff also notes that in describing the coolant treatment and boron recovery features of the CVCS, the applicant did not refer to the use of enriched boron. The boric acid solution in the CTS boric acid column is measured and controlled to maintain its boric acid concentration at an approximately constant four percent by weight, which corresponds to 7100 ppm ± 100. The solution is cooled and transferred to the RBWMS storage tanks for reuse in the CVCS makeup. The staff notes that in FSAR Tier 2, Table 6.8-1, "Extra Borating System (EBS) Design and Operating Parameters," the applicant stated that boron concentration in the tank is 7000 to 7300 ppm, indicating the CVCS and EBS have a similar boron concentration range. However, the EBS uses enriched boron. In FSAR Tier 2, Table 6.8-1, the applicant states the minimum boron enrichment is 37 percent B-10. Therefore in RAI 125, Question 09.03.04-2, the staff requested that the applicant describe the reasons for using enriched boron in the CVCS, including any advantages and disadvantages. The staff also noted that FSAR Tier 2, Section 9.3.4 does not discuss the EBS and design basis events for which each of these two systems are used, or the interfaces between the CVCS and the EBS, and requested that the applicant describe these interfaces. In a December 5, 2008, response to RAI 125, Question 09.03.04-2, the applicant stated that a four weight percent boric acid (H_3BO_3) solution corresponds to approximately 7000 ppm boron. The statement "7100 ppm ± 100" was a typographical error and was corrected to "7000 ± 100 ppm boron" in FSAR Revision 1.

The applicant also stated that naturally occurring mineral sources of boron contain two isotopes, B-10 at 19.9 atom percent and B-11 at 80.1 atom percent. Enriched boric acid (EBA) contains a higher atom percent of B- 10 than natural boric acid (NBA). Enriching the B-10 isotope decreases the atom percent of B- 11. The net effect is a decrease in the overall boric acid concentration since the effective number of B-10 atoms per gram is the same for a given level of soluble reactivity control.

The applicant also explained that use of a boric acid solution makes the reactor coolant slightly acidic at operating conditions. Therefore, lithium is added to the reactor coolant (as lithium hydroxide, LiOH) to neutralize the boric acid and produce a slightly basic pH at operating conditions. Operating with a slightly basic coolant reduces the generation and mobility of corrosion products in the RCS. Minimizing corrosion products is important since their activation increases the source term. Corrosion product reduction also minimizes the potential for axial offset anomaly and for crud-induced fuel corrosion.

However, lithium hydroxide accelerates Zircaloy cladding corrosion, with the corrosion depending on the amount of lithium picked up by the cladding oxide. This, in turn, depends on the reactor coolant lithium concentration, the heat flux, the zirconium oxide layer thickness, and the cladding composition. A maximum lithium concentration is established to limit the lithium concentration in the cladding oxide. The use of EBA lowers the reactor coolant boron concentrations required during all operating modes. This limit may delay achieving a constant and slightly basic pH in the coolant at beginning of cycle (BOC). If a high BOC boron concentration is needed, the boron concentration can be reduced by B-10 enrichment. To achieve a slightly basic pH in the coolant at BOC requires less lithium, which, in turn, lowers the Zircaloy corrosion throughout the fuel cycle.

The applicant described the EBS in FSAR Tier 2, Section 6.8," Extra Borating System." The interfaces between the EBS and the CVCS are addressed in FSAR Tier 2, Section 6.8.2," System Description," which describes how the EBS pumps taking suction from the CVCS volume control tank and discharge to the CVCS seal injection header for hydrostatic testing of the RCS.

The staff considers RAI 125, Question 09.03.04-2 resolved because the staff agrees with the applicant's explanation that an increase in enriched B-10 concentration would lower the overall boron concentration level while maintaining the same level of neutron absorption; thus, resulting in a lower Zircaloy corrosion effect throughout the fuel cycle. In addition, the staff confirmed that the applicant corrected the boron concentration to 7000 +/- 100 ppm in FSAR Revision 1.

The staff notes that major system components include two multi-stage vertical centrifugal charging pumps, a regenerative heat exchanger, two high-pressure coolers, filters, ion exchangers, and a volume control tank. The applicant provided flow diagrams and CVCS piping and instrument diagrams are provided in FSAR Tier 1, Figure 2.2.6-1, "Chemical and Volume Control System Functional Arrangement," and FSAR Tier 2, Figures 9.3.4-1 through 9.3.4-6. The drawings provide equipment locations along with system interconnections, pressure and temperature ratings, and safety or seismic classifications.

The applicant also stated that during plant startup, the CVCS is used to fill the RCS, establish RCP seal injection flow, and control RCS inventory and chemistry during plant heat-up. Oxygen remaining from shutdown or refueling is removed by diverting letdown to the coolant degasification system (CDS). The CDS operates as a vacuum degasifier, at a pressure of 11.7 kPa (1.693 psia), which removes radioactive gases as well as hydrogen and oxygen. As the heat-up proceeds, and prior to reaching 121 °C (250 °F), lithium hydroxide is added to the RCS to adjust the reactor coolant pH. The hydrogenation station is also placed in operation to provide the required hydrogen to assure the RCS is consistent with chemistry requirements.

Reactor coolant pumps are used for RCS heat-up. During the heat-up, the expanding RCS inventory is removed through a three-way valve in the letdown line that discharges excess coolant to the coolant supply and storage system (CSSS). The pressurizer level is maintained at its set-point throughout startup, and RCP seal injection is controlled at approximately 30 l/min (8 gpm) to each operating pump.

After plant shutdown, boron concentration is increased prior to and during cool-down and RCS depressurization. The reactor boron and water make up system supplies borated water to the CVCS, with excess water being diverted to the coolant supply and storage system. If the reactor vessel is opened, coolant is diverted to the degasification system to remove both fission gases and hydrogen. During the initial phases of the cool-down (with cool-down by the steam generators and turbine bypass), two charging pumps are in operation to prevent the letdown flow from being reduced to a minimum value. When RCS depressurization is complete, the charging pumps are secured and bypassed. At this time, low head safety injection and residual heat removal (RHR) pumps can inject water into the RCP seals, or the RCP seal flow can be isolated.

Under accident conditions, the CVCS operates normally except when a SIS signal, CIS signal, or high pressurizer level signal is received. The SIS signal shuts automatic isolation valves in the reactor coolant pressure boundary. The Stage-1 CIS signal isolates the letdown line, but the RCP seal injection and leak-off lines and charging lines continue to operate. A Stage-2 CIS signal isolates seal injection and charging, along with the letdown line. In this case, the charging pumps continue to operate on minimum flow recirculation. The high pressurizer level signal isolates the charging and the auxiliary spray lines.

The staff reviewed the accident evaluation descriptions provided in FSAR Tier 2, Section 15, “Transient and Accident Analyses,” and identified two scenarios which referred to switchover from the VCT to the IRWST: FSAR Tier 2, Section15.4.6, “Chemical and Volume Control System Malfunction that Results in a Decrease in the Boron Concentration in the Reactor Coolant,” and Section 15.6.3, “Steam Generator Tube Rupture.” The staff also noted that boron dilution occurs also during a SBLOCA, FSAR Tier 2, Section 15.6.5, “Loss of Coolant Accidents Resulting from Spectrum of Postulated Piping Breaks Within the Reactor Coolant Pressure Boundary,” where the IRWST is referenced, but in the context of CVCS. In RAI 125, Question 09.03.04-5, the staff requested that the applicant clarify the statements related to the IRWST references in these FSAR Tier 2 sections. In a December 5, 2008, response to RAI 125, Question 09.03.04-5, the applicant provided an explanation of the functional purpose of the switchover from the VCT to the IRWST for the events described in the RAI that would determine the applicability of IRWST borated water of being credited in the transient analysis. The applicant’s explanation is summarized below.

The boron dilution event is terminated by closing the three safety-grade motor operated valves that automatically isolate the normal letdown line and the line from the VCT. No credit is taken for the automatic switchover to the IRWST because the event has been terminated and the purpose of the switch over to the IRWST is to allow the charging pump to continue to operate in providing flow to the reactor coolant pump seals.

In the steam generator tube rupture event the charging pumps are automatically switched to the IRWST on a low level in the VCT. This allows the charging pumps to offset the coolant loss through a single steam generator tube failure. The reason credit is taken for the switch over to the IRWST is that the transient is extended because the operator trips the reactor instead of an automatic reactor trip occurring. This results in a longer time for event identification and thus an additional loss of reactor coolant into the faulted steam generator.

The IRWST is referred to in FSAR Tier 2, Section 15.6.5 to provide the suction temperature for the medium head safety injection and low head safety injection pumps, which are used to mitigate a SBLOCA. The chemical volume control system does not perform any safety function in mitigating a SBLOCA.

The staff considers RAI 125, Question 09.03.04-5 resolved because the staff concurs with the applicant's explanation that addressed the CVCS and IRWST functional application with respect to the transient analysis of the events described in the RAI.

- Quality group classifications for the CVCS system are identified in FSAR Tier 1, Figure 2.2.6-1 and FSAR Tier 2, Figure 9.3.4-1. Classifications are also given in FSAR Tier 1, Table 2.2.6-1. The staff reviewed these drawings and tables as related to the quality group and seismic categories for the safety-related portions of the system. The staff finds that the supply piping from the RCS to the CVCS can be isolated by two (in series) motor-operated valves and that both injection lines returning to the RCS loops are isolated by sets of two check valves (also in series). All of these valves are shown in FSAR Tier 1, Table 2.2.6-1 as ASME III, Code Class 1 valves. However, this table does not show the piping between the two motor-operated valves or between the two check valves to be ASME Code Class 1. Therefore in RAI 125, Question 09.03.04-6, the staff requested that the applicant include this piping in FSAR Tier 1, Table 2.2.6-1, so that the CVCS ITAAC inspectors can confirm the design qualifications of the piping up to the second isolation valve as being ASME Code Class 1. Also, the pressurizer auxiliary spray line is isolated from the RCS by a check valve and a motor-operated valve (MOV). The check valve is ASME Code Class 1, but the MOV is ASME Code Class 3. Accordingly, in RAI 125, Question 09.03.04-6, the staff requested that the applicant provide further justification for this design. In a February 18, 2008, response to RAI 125, Question 09.03.04-6, the applicant stated that the pressurizer auxiliary spray isolation valve is classified as Code Class 3 rather than Code Class 1 because there are two Code Class 1 check valves in series from the RCS pressure boundary. The check valves are shown on FSAR Tier 2, Figure 9.3.4-1, "Chemical and Volume Control System," Sheet 5, and FSAR Tier 2, Figure 5.1-4, "RCS Piping and Instrumentation Diagram," Sheet 3. The staff reviewed these drawings and concurred that the two Code Class 1 check valves in series satisfy RCS pressure boundary requirements. Therefore, the staff considers RAI 125, Question 09.04.04-6 resolved.

The staff notes when a potential boron dilution event is detected by concentration-measuring instruments, the CVCS automatically shifts charging pump suction from the VCT and from the normal letdown line to the borated IRWST. Motor-operated isolation valves from the VCT and the letdown line automatically close, and a motor-operated isolation valve from the IRWST automatically opens. The VCT and letdown isolation valves are shown on the piping and instrument diagram as Quality Group C and Seismic Category I. The valve that appears to be the IRWST isolation valve is 30KBA31 AA0013, which is shown on FSAR Tier 2, Figure 9.3.4-1, sheet 4 of 9. However, this valve is classified as Quality Group D and Non-Seismic. The staff found this classification acceptable because RCS boration is not a CVCS safety function.
In RAI 125, Question 09.03.04-7, the staff requested that the applicant address the reliability of this valve during a boron dilution event. In a December 5, 2008, response to RAI 125, Question 09.03.04-7, the applicant stated that the CVCS is identified as a safety-significant system by the Reliability Assurance Program (RAP) and that the in-containment refueling-water storage tank suction valve (30KBA31 AA0013) will be included in the RAP. The applicant also stated that the safety function to mitigate a boron-dilution event ended with isolation of the charging pump suctions from the VCT and the normal letdown path. The applicant agreed to correct FSAR Tier 2, Section 9.3.4.1 to remove the statement that alignment to the IRWST was a safety-related function of the CVCS. The staff reviewed this response and the proposed

FSAR change and finds the information adequate. The staff considers placing the IRWST suction valve in the RAP an adequate action and considers RAI 125, Question 09.03.04-7 resolved.

Accordingly, the staff concludes that the CVCS design complies with the requirements of GDC 1. Safety-related portions of the CVCS are located in the fuel building or in the reactor building. Both structures are designed to withstand the effects of earthquakes, tornadoes, hurricanes, and other natural phenomena. The bases for the adequacy of the designs of these buildings are provided in FSAR Tier 2, Sections 3.3, "Wind and Tornado Loadings"; 3.4, "Water Level (Flood) Design"; 3.5, "Missile Protection"; 3.7, "Seismic Design"; and 3.8, "Design of Category I Structures." Safety-related portions of the CVCS are also designed to remain functional during and after a safe-shutdown earthquake, with design loadings identified in FSAR Tier 2, Sections 3.7 and 3.9, "Mechanical Systems and Components." Based on the information found in these sections, and the fire protection information in FSAR Tier 2, Section 9.5.1, "Fire Protection System," the staff finds that the safety-related portions of the CVCS are adequately protected from the effects of natural phenomena and that the system design comply with the requirements of GDC 2.

The staff also noted that FSAR Tier 2, Section 9.3.4.3 "Safety Evaluation" states that the safety-related portions of the CVCS meet RG 1.29, Regulatory Position C.1 and the non-safety portions meet RG 1.29, Regulatory Position C.2. RG 1.29, Regulatory Position C.2 (SSC requires a design that precludes equipment or piping failure during an SSE that can adversely affect safety-related equipment (i.e., Seismic Category II). However, FSAR Tier 2, Figure 9.3.4-1 identifies non-safety portions of the CVCS as non-seismic classification (NSC), which does not imply the protection of Seismic Category II piping. Therefore in RAI 125, Question 09.03.04-8, the staff requested that the applicant clarify the classifications shown on the drawings. In a January 20, 2009, response to RAI 125, Question 09.03.04-8, the applicant stated that seismic design classifications of the CVCS components are provided in FSAR Tier 2, Table 3.2.2-1, "Classification Summary," and are consistent with the guidance provided in SRP Section 3.2.1, "Seismic Classification." The applicant also referred to the November 14, 2008, response to RAI 71, Question 03.02.01-5, for further details of the methodology for classifying SSCs.

The applicant stated that non-safety-related component designation as Seismic Category II depends on potential component failure-modes and consequences, the proximity of safety-related (Seismic Category I) components, and the vulnerability of those components to the consequences of the failure mode of the non-safety component in question. The applicant stated that non-seismic lines and associated equipment are routed, to the extent possible, outside of safety-related areas to avoid potentially adverse interactions. In the event that this routing is not possible and non-seismic lines must be routed in safety-related areas, the non-seismic items are evaluated for seismic interactions (FSAR Tier 2, Section 3.7.3.8, "Interaction of Other Systems with Seismic Category I Systems"). The applicant concluded that failure of the non-safety-related, non-seismic portions of the CVCS would not prevent or degrade the functioning of any safety-related Seismic Category I component of the CVCS.

In the November 14, 2008, response to RAI 71, Question 03.02.01-5, the applicant stated that design documentation, including seismic classifications for SSCs within the scope of FSAR Tier 2 is provided in the following documents types, which are available for NRC inspection.

- System Design Requirements Documents (SDRD)

- System Description Documents (SDD)
- Piping and Instrument Diagram

The staff reviewed the applicant's January 20, 2009, response to RAI 125, Question 09.03.04-8, including the response to RAI 71, Question 03.02.01-5 and the information in FSAR Tier 2, Table 3.2.2-1 and notes that most CVCS components in FSAR Tier 2, Table 3.2.2-1 were Seismic Category I, with some Seismic Category II. In view of the information provided, the staff concludes that the responses are acceptable and that the applicant has sufficiently addressed seismic to non-seismic interactions for the CVCS and finds that the applicant has complied with requirements of GDC. Therefore, the staff considers RAI 125, Question 09.03.04-8 resolved.

In addition, the staff noted that FSAR Tier 2, Figure 9.3.4-5, “Coolant Supply and Storage System,” shows that the storage tanks that feed the coolant treatment system (boron recovery) are non-seismic and Quality Group D. Since the CSSS is a non-safety-related subsystem of CVCS that provides no functional support, during a transient, to any safety-related system described in the mitigation of events in FSAR Tier 2, Chapter 15, “Transient and Accident Analyses,” there is no FSAR Tier 1 ITAAC section associated with CSSS. Since the CSSS is infrequently operated, the system is equipped with remote operated manual valves to isolate, shutdown, and drain the equipment. Also, radiation and leakage detection monitoring is provided in the vicinity of CSSS with alarming capability in the MCR.

FSAR Tier 2, Section 9.3.4.3 states that the CVCS provides flow to the coolant purification system (CPS) and the CDS to maintain purity levels in the reactor coolant. This section also states that chemical additions through the CVCS maintain chemistry in accordance with technical specifications that also meet the latest EPRI guidance. The applicant concludes that these provisions maintain RCPB material integrity in order to comply with the requirements of GDC 14.

The FSAR states that the CVCS is not designed to provide the safety function for RCS boration to mitigate design basis events. The CVCS does control boron concentration under normal operating conditions and is also designed to mitigate boron dilution events, should one occur, by automatically shifting charging pump suction from the normal letdown line and the VCT to the borated in-containment refueling IRWST. As such, CVCS precludes safety system operation in response to a boron dilution event. When a boron dilution event is detected, motor-operated valves automatically isolate the VCT and the letdown line and automatically open the suction line to the IRWST. This same automatic charging pump suction transfer occurs on a low VCT level signal. Consequently, the CVCS mitigates or terminates boron dilution events by isolating letdown and the source of the likely reduced-boron water (the VCT) but does not credit the subsequent boration of the RCS since boration would require operation of non-safety grade equipment, such as the charging pumps themselves. Accordingly, the staff considers that the CVCS design complies with the requirements of GDC 29.

The staff notes that the CVCS is not required to supply reactor coolant makeup to mitigate small breaks or leaks in the reactor coolant pressure boundary; although CVCS can function to make-up inventory from small leaks or breaks in order to prevent ECCS system actuation. The staff also notes that the CVCS is not designed to perform any safety functions of the ECCS during a design basis accident. In view of these findings, the staff concludes that GDC 33 with regard to reactor coolant makeup and GDC 35 with regard to emergency core cooling do not apply to the chemical and volume control system of the U.S. EPR.

Piping from CVCS component vents and drains connect to the nuclear island vent and drain system. Connection points are schematically shown in FSAR Tier 2, Figure 9.3.4-1 (sheet 8 of 9) along with other sheets in FSAR Tier 2, Figure 9.3.4-2 to Figure 9.3.4-6. In addition, gaseous wastes that are discharged from the CVCS are collected and processed by the gaseous waste processing system, as shown in various sheets in drawings in FSAR Tier 2, Figure 9.3.4-1 to Figure 9.3.4-6. These diagrams indicate that the CVCS vents and drains will be processed through liquid and gaseous waste handling and processing systems. Accordingly, the staff finds that the CVCS design complies with GDC 60. In addition, the applicant states that the system design provides suitable radiation shielding with containment and confinement to permit personnel access while maintaining low exposure, that radioactive components are segregated from non-radioactive, and that the layout permits periodic inspections and maintenance. Accordingly, the staff also concludes that the CVCS design complies with the requirements of GDC 61.

The staff notes CVCS components and piping are designed to permit isolation without compromising safety functions. If the VCT level decreases from its normal value, an alarm sounds in the MCR and automatic makeup is initiated. At the minimum allowable level, another alarm is sounded and the charging pump suction source is automatically shifted from the VCT to the IRWST. Similarly on a high VCT level, an alarm sounds in the MCR and letdown flow is diverted to tanks in the coolant supply and storage system.

In addition to the VCT water level alarms, breaks or leaks in the CVCS outside containment can be identified by pressure and temperature measurements in the letdown line, high water level in the fuel building sump, and increased activity measurements in the fuel building ventilation system. When leaks or breaks are detected, letdown flow can be isolated by four high pressure isolation valves in series. If the charging line were to break, redundant check valves, in series, would isolate the break from the reactor coolant system. The resulting low charging pump discharge pressure trips the charging pumps and terminates charging flow. If a tube rupture occurs inside a high pressure (HP) cooler, the CVCS water would flow into the component cooling water (CCW) system. The CCW system is protected from overpressure by relief valves. An increase in CCW flow or an increase in radioactivity would indicate the existence of a leak. CCW high activity measurement signals automatically isolate the CVCS HP coolers.

The CVCS safety-functions must be accomplished in spite of malfunctions or postulated single-failures of active components. In isolating the RCS pressure boundary, FSAR Tier 2, Figure 9.3.4-1 shows that the charging and letdown lines are isolated by two valves in series on each line. Therefore, the safety function of RCPB isolation will be achieved in spite of a single valve failure. Similarly, FSAR Tier 2, Figure 9.3.4-1 shows that CVCS containment isolation functions are performed by two valves in series, and that this function will be achieved under single failure conditions. Three valves automatically close to mitigate a boron dilution event, one of which is in a common line to the charging pumps. In this configuration, the letdown line and the line from the VCT are isolated even if one of the three valves fails to close. For CVCS safety function of charging isolation to preclude RCS over fill, the staff was unable to determine that this function can be achieved in spite of a single failure. Therefore, in RAI 125, Question 09.03.04-9, the staff requested that the applicant provide additional information on the valves that perform this function. In a December 5, 2008, response to RAI 125, Question 09.03.04-9, the applicant stated that charging isolation to preclude RCS overfill is achieved in the event of a single active component failure. Three safety-related isolation valves close to terminate an overfill event. The event is terminated if the charging line containment isolation valve closes (valve 30KBA34 AA002), or if both the charging line isolation valve (valve 30KBA34 AA012) and the pressurizer auxiliary spray line isolation valve (valve 30KBA35

AA001) close. Valve AA002 is powered from a different emergency bus than the emergency power bus for valves AA012 and AA001. In addition, both emergency buses are capable of being powered from alternate sources. Therefore, no single failure (mechanical or electric) precludes fill isolation.

The staff finds that the applicant has addressed the single failure criteria and considers RAI 125, Question 09.03.04-9 resolved. The staff concludes that the CVCS safety functions can be performed under single active-failure conditions. Also, none of the specific safety-functions discussed above require cooling water, so the CVCS safety functions can be achieved without cooling water. Accordingly, the staff concludes that further CVCS failure modes and effects analysis is not required.

10 CFR 50.34(f)(2)(xxvi), the CVCS system, Section 9.3.4.1, “Design Bases,” states that safety-related portions of the CVCS are designed to have provisions for a leakage detection and control program to minimize the leakage from those portions of the CVCS outside of the containment that contain or may contain radioactive material following an accident (10 CFR 50.34(f)(2)(xxvi)).

FSAR Tier 2, Section 9.3.4.3, “Safety Evaluation,” states that the design of safety-related portions of the CVCS complies with 10 CFR 50.34(f)(2)(xxvi) regarding detection of reactor coolant leakage outside the containment by providing leakage control and detection systems in the CVCS and implementation of appropriate leakage control program.

- The CVCS isolates components or piping so that the CVCS safety function is not compromised. Design provisions include the capability to identify and isolate the leakage or malfunction, and to isolate the non-safety-related portions of the system.

FSAR Tier 2, Section 9.3.4.2.3.5, “Accident Conditions,” contains the following information with regard to detecting system leaks outside containment:

> Postulated System Leaks in the Fuel Building - In the event of a CVCS or RCP seal water system leak in the Fuel Building, reactor coolant with temperatures of approximately 120°F is released.

Due to the loss of reactor coolant, the following alarms are also generated:

- VCT (volume control tank) low water level
- Sump high water level in the FB vent and drain system

In RAI 237, Question 09.03.02-16, the staff requested that the applicant provide additional information with respect to compliance with 10 CFR 50.34(f)(2)(xxvi). With respect to the CVCS, the staff requested that the applicant describe how leakage is identified and located using the sump level alarms; a clarification of Technical Specification 5.5.2 to list the specific in-scope systems, confirmation that the technical specification is intended to fulfill the 10 CFR 50.34(f)(2)(xxvi) requirements; and the initial test program information. In an August 12, 2009, response to RAI 237, Question 09.03.02-16, the applicant indicated that the sump level indication is too gross to comply with 10 CFR 50.34(f)(2)(xxvi), and the primary means of detecting and minimizing leakage would be through the program described in the Technical Specification 5.5.2. The applicant provided a markup of Technical Specification 5.5.2 including CVCS among the in-scope systems, and provided a markup of FSAR Tier 2, Section 14.2.12.12.7 providing the initial test program information for the systems subject to 10 CFR 50.34(f)(2)(xxvi), including CVCS.

For the CVCS, since the applicant has provided for leakage control and detection in the design of systems outside containment that contain (or might contain) accident source term radioactive materials following an accident, and submitted a leakage control program, including an initial test program, a schedule for re-testing these systems, and the actions to be taken for minimizing leakage from such systems, as required by 10 CFR 50.34(f)(2)(xxvi), the staff finds the applicant's August 12, 2009, response to RAI 237, Question 09.03.02-16 acceptable for the CVCS system. The staff has confirmed that the proposed changes were incorporated into Revision 2 of the FSAR.

FSAR Tier 2, Chapter 16, Technical Specification (TS) 3.4.12, "RCS Operational LEAKAGE," identifies allowable RCS operational leakage. TS 3.4.12 allow up to 3.8 l/min (1 gpm) of unidentified leakage, 38 l/min (10 gpm) of identified leakage, and 568 l/day (150 gal/day) of primary to secondary leakage through each steam generator. These allowable leakages are used in the LOCA analyses both from the standpoint of the probability of an event and the amount of leakage assumed in the analyses. In view of the system features to detect and isolate potential leakage discussed above, the staff finds that the CVCS system complies with the requirements of 10 CFR 50.34(f)(2)(xxvi) with respect to leakage detection and control programs to minimize leakage from portions of the CVCS outside containment following an accident. In addition to leak detection, CVCS piping that contains boric acid must either be heat traced or located in heated rooms to prevent boric acid precipitation. FSAR Tier 2, Section 9.3.4.2.1 states that the boric acid piping is contained in heated rooms. The staff finds design provisions relative to leakage and boron precipitation acceptable.

The CVCS is operated from the main control room, with the control functions performed with the process information and control system (PICS). If the PICS is unavailable, CVCS safety functions can be performed with the safety information and control system (SICS). System instruments provide input signals to monitor parameters and generate alarms. Indications and alarms are provided for pressure, temperature, flow, level, and boron concentration. The staff reviewed system monitoring and control provisions described in FSAR Tier 2, Section 9.3.4.5 and conclude that these features are adequate to verify proper system operation. At the same time, the staff notes that a low charging-pump suction pressure alarm trips the operating charging pumps. The FSAR did not provide further details on this trip function, and it was unclear to the staff how the trip function is controlled during an automatic swap of suction sources from the volume control tank to the in-containment refueling water storage tank. Therefore, in RAI 125, Question 09.03.04-10, the staff requested that the applicant provide further details on this trip function. In a December 5, 2008, response to RAI 125, Question 09.03.04-10, the applicant stated that during the swap-over of the charging pump suction to the IRWST, charging pump suction is maintained. The valves that isolate the letdown line and VCT and the valve from the IRWST receive their close/open signals simultaneously. The travel time for all the valves is the same. A check valve in the line from the IRWST prevents reverse flow from the VCT. As the valves from the letdown line and VCT close, suction pressure is reduced to the static head of water in the IRWST as the IRWST isolation valve opens. Flow then proceeds from the IRWST to the charging pump suctions.

The staff reviewed this information and elevation drawings for the IRWST (containment building) and the charging pump rooms (fuel building) shown in FSAR Tier 2, Section 3.8. The staff concludes that under the proposed design, static head from the IRWST would be available to the charging pump suctions before the letdown and VCT supply lines would be fully isolated, thereby precluding the low suction pressure trip. The staff finds the December 5, 2008, response to RAI 125, Question 09.03.04-10 acceptable and considers RAI 125, Question 09.03.04-10 resolved.

FSAR Tier 2, Table 9.3.4-1 shows that the charging pump minimum flow (recirculation flow) is 150 l/min (40 gpm), while the normal charging flow rate is 665 l/min (176 gpm). Therefore, recirculation flow is approximately 23 percent of normal charging pump flow. The charging pumps are not safety-related components and are not relied upon to mitigate either design basis accidents or anticipated operational occurrences. Accordingly, the staff finds the minimum recirculation flow rate a reasonable value and did not further evaluate minimum flow requirements.

Temperature measurements and temperature alarms are provided at several points in the letdown line. Temperature is measured upstream of the regenerative heat exchanger, downstream of the HP coolers, and downstream of the HP reducing station. A high temperature signal downstream of the reducing station causes an alarm in the main control room and automatically closes the three-way valve to bypass the coolant purification system, closes a three-way valve to bypass the degasification system, and isolates the low pressure (LP) reducing station. These automatic features protect demineralizer resins from high temperature conditions. In addition to the above, differential pressures are measured across the purification system inlet filters and mixed-bed ion exchangers. On high differential pressures across either the filters or ion exchangers, the purification system is bypassed by shifting of the three-way valve. In view of these features, the staff finds the purification system protections from abnormal pressures and temperatures adequate.

The VCT is maintained at a constant pressure by a continuous gas feed-and-bleed. By this process, fission gases and hydrogen are continuously removed from the tank. At the same time, the VCT is designed for vacuum conditions with its design pressure being from 1.38 kilopascal (kPa) (-14.5 pounds per square inch (psig)) to 1308 kPa (175 psig). Low pressure CVCS tanks and hold-up tanks that contain primary system water are continuously vented to prevent vacuum conditions. Accordingly, based on the foregoing, the staff finds system tank designs acceptable.

FSAR Tier 2, Section 9.3.4.1, states that safety-related portions of the CVCS provide capacity and capability to assure the core is cooled in the event of a station blackout. However, FSAR Tier 2, Section 9.3.4.3, "Safety Evaluation," states that CVCS provides no function with regard to RCS makeup or RCP seal injection during a station blackout event and, therefore, 10 CFR 50.63 is not applicable to CVCS. In addition to these potentially conflicting statements, the SBO coping descriptions of FSAR Tier 2, Section 8.4 are not clear on how reactor coolant inventory is maintained under SBO conditions. FSAR Tier 2, Section 8.4 discusses assumptions of RCP seal leakage in an SBO and also discusses the RCP standstill seal system that subsequently terminates seal leakage. However, the issue of makeup and volume control is not explained. Therefore in RAI 125, Question 09.03.04-11, the staff requested that the applicant provide additional information regarding CVCS functions during an SBO. In a December 5, 2008, response to RAI 125, Question 09.03.04-11, the applicant stated that CVCS provides no station blackout mitigation function. The applicant stated that the statements in FSAR Tier 2, Section 9.3.4.1, "Design Basis," are restatements of the requirements identified in the acceptance criteria of the Standard Review Plan (NUREG-0800). The statements provided in FSAR Tier 2, Section 9.3.4.3, "Safety Evaluation," are statements that indicate how the CVCS meets the Standard Review Plan. The applicant concluded that the FSAR will not be changed as a result of RAI 125, Question 09.03.04-11.

In conjunction with FSAR Tier 2, Section 8.4.2.6.2 and RAI 70, Question 08.04-6, the staff reviewed the SBO mitigation strategy timeline with respect to CVCS and RAI 125, Question 09.03.04-11. Prior to the SBO event, the RCS leakage rate is based on the technical specifications limits of (1 gpm (0.063 l/s)) for unidentified leakage and ten gpm for identified leakage. Approximately 10 minutes into the SBO event, the RCS pump seals fail which adds about 100 gpm (6.31 l/s) RCS leakage rate to the initial leakage rate. Around 15 minutes into the event, standstill seal system reduces the seal leakage to (2 gpm (0.126 l/s)) for the duration of the 8 hour coping period. When the RCS leakage rate is integrated over the 8 hour coping period, the total leakage is approximately (7,510 gal (28.43 kiloliters)). This equates to around a 5 foot drop in the RCS inventory level; thus, the RCS inventory level remains well above the top of the fuel. Therefore, the CVCS is not required for makeup to the RSC during the coping period. Accordingly, the staff finds the response to RAI 125, Question 09.03.04-11 acceptable and considers this RAI resolved.

FSAR Tier 1, Section 2.2.6 describes FSAR Tier 1 attributes of the chemical and volume control system. FSAR Tier 1 mechanical equipment is listed in FSAR Tier 1, Table 2.2.6-1, electrical equipment in FSAR Tier 1, Table 2.2.6-2, and ITAAC requirement in FSAR Tier 1, Table 2.2.6-3. CVCS system interlocks are listed in FSAR Tier 1, Section 2.2.6, paragraph 4.4. This section lists the three motor-operated valves that must close to isolate the charging pump suctions in a boron dilution event. The staff finds the FSAR Tier 1 entries associated with CVCS, including the ITAAC requirements, acceptable.

The Technical Specifications associated with FSAR Tier 2, Section 9.3.4 are given in FSAR Tier 2, Chapter 16, Sections 3.1.8 (boron dilution protection) and 3.9.1 (boron concentration). The staff finds the requirements of TS 3.1.8 sufficient to assure isolation of the VCT suction and normal letdown line in a boron dilution event.

Initial plant testing is prescribed in FSAR Tier 2, Section 14.2. Numerous startup tests are associated with CVCS, as follows:

1. Test #002 Volume Control Tank

2. Test #003 Charging and Seal Injection

3. Test #004 CVCS Letdown

4. Test #005 Chemical Addition

5. Test #006 Coolant Supply & Storage System

6. Test #007 Reactor Boron and Water Makeup System

7. Test #008 Boric Acid Mixing Tank

8. Test #009 Boric Acid Storage Tank

9. Test #010 Coolant Degasification System

10. Test #011 Coolant Purification System

11. Test #096 Reactor Coolant Drain Tank

12. Test #126 Boron Concentration Measurement System

13. Test #173 Pre-Core CVCS Integrated Test

14. Test #176 Pre-Core Boration and Dilution Measurements

In each of the above tests, the acceptance criteria involve satisfying the design basis requirements of FSAR Tier 2, Section 9.3.4. The tests typically record system parameters, alarm settings, interlocks, and numerous other system features. The staff reviewed these test requirements, along with the planned ITAAC testing of FSAR Tier 1, Table 2.2.6-3 and finds this testing acceptable in accordance with its design basis objectives.

FSAR Tier 2, Table 1.8-2, "U.S. EPR Combined License Information Items," lists COL information items that are required of the COL applicant to supply information or action to supplement the certified design. There are no information items in this table related to CVCS. The staff did not identify additional COL information items that should be added to FSAR Tier 2, Table 1.8-2 for CVCS. Therefore, the staff finds FSAR Tier 2, Table 1.8-2 acceptable for the CVCS.

9.3.4.4.2 Chemistry Aspects

The staff reviewed the chemistry aspects of the CVCS in accordance with NUREG-0800, Section 9.3.4 "Chemical and Volume Control System (PWR) (Including Boron Recovery System)," Revision 3, March 2007. The staff acceptance of the design is based on complying with the requirements of GDC 14, GDC 29, GDC 33, and GDC 60. The following is a discussion of the regulatory requirements and how they are met.

NUREG-0800, Section 9.3.4 identifies the functional chemistry objectives for the CVCS as:

- GDC 14, as it relates to minimizing concentrations of contaminants so that the RCPB is not challenged.
- GDC 29, as it relates to maintaining boron control to avoid reactivity excursions.
- GDC 33, as it relates to reducing the amount of liquid waste so that ALARA can be achieved via recycle of radioactive fluids or contained system connections to waste processing systems. By providing a cleanup system that recycles RCS liquids, the capability to supply makeup water is enhanced, as larger volumes of "new" liquid are not required.
- GDC 60 and GDC 61, as they relate to the control of release of radioactive materials by providing appropriate confinement and holdup capacity for radioactive effluents.

These general objectives are described in FSAR Tier 2, Section 9.3.4 and its associated figures.

FSAR Tier 1, Section 2.2.6 has no chemistry-related ITAAC for the CVCS system.

FSAR Tier 2, Section 9.3.4.1 describes the chemistry-related functions of the CVCS as follows:

- Maintain water chemistry quality so that the RCPB integrity is protected.
- Safety-related portions of the CVCS have provisions for venting and draining of radioactive materials through closed systems to minimize radiological effluents.

- Maintain and adjust boron concentration to control reactor power level or provide sufficient amount of boron to allow for sufficient shutdown margin based on neutron absorption.

- Provide purified and filtered water to the reactor coolant pump seals to maintain the integrity of that particular RCPB.

- Provide for chemical and radiochemical control of the reactor coolant liquid.

- Provide a means for addition of reactivity and chemical control agents to the RCS to maintain low corrosion rates in the RCS.

These features of the CVCS system support the objectives of the GDC by maintaining the integrity of the RCPB.

The major components of the CVCS are located in the Fuel Building. The system initiates from the intermediate leg of Loop 1 of the RCS with liquid directed through the regenerative heat exchanger. The materials of construction of this heat exchanger and the two, parallel letdown heat exchangers (downstream of the regenerative heat exchanger) are stainless steel and are appropriate for the chemical environment.

The CVCS system supports the intent of GDC 60 by recovering water recirculated/flushed prior to sampling and supports the intent of GDC 33 by re-using water that has in the past gone to liquid waste processing and minimizing new coolant water that needs to be provided. Details for the recovered water for sampling are discussed in FSAR Tier 2, Section 9.3.2 for the NSS. Other portions of the CVCS system that are not reused are directed through hard piping connections to the Nuclear Island vent and drain system (NIVDS) also in keeping with the requirements of GDC 33.

The staff finds the CVCS meets the requirements of GDC 60 and GDC 61 with respect to confining radioactivity by venting and collecting drainage from the CVCS components through closed systems.

The volume of the borated water storage tanks and their means of injection into the RCS provide a rapid and appropriate level of reactivity control material. The volumes of resins and associated tanks in CVCS are of appropriate size and design to meet the needs of the maintenance of high purity, reactor coolant water.

The CVCS materials of construction and the water chemistry control described are commensurate with the requirements of GDC 14 for protecting the RCPB. In accordance with the recommendation of SRP Section 9.3.4, FSAR Tier 2, Section 9.3.4.3 references the EPRI PWR Primary Water Chemistry Control Guidelines as the basis for the water chemistry requirements maintained by the CVCS.

Although the staff does not formally review or issue a safety evaluation of the various EPRI water chemistry guidelines (including the PWR Primary Water Chemistry Guidelines), the guidelines are recognized as representing industry best practices in water chemistry control. Extensive experience in operating reactors has demonstrated that following the EPRI guidelines minimizes the occurrence of corrosion related failures. Further, the EPRI guidelines are periodically revised to reflect evolving knowledge with respect to best practices in chemistry control. Therefore, the staff accepts the use of the EPRI PWR Primary Water Chemistry

Guidelines as a basis for a recommended primary water chemistry program for a standard reactor design.

FSAR Tier 2, Section 5.2.3 references the latest published revision of the EPRI PWR Primary Water Guidelines (Revision 5, EPRI Report No. 1002884, September 2003) as the basis for the primary water chemistry requirements. FSAR Tier 2, Table 5.2-2 provides the normal limits for chemical additives and impurities for the reactor coolant. The staff finds the normal operating values for dissolved oxygen and impurities acceptable, since the values are consistent with, or conservative compared to the action levels specified in the latest edition of the EPRI PWR Primary Water Chemistry Guidelines. However, since the action levels defined by the EPRI guidelines require specific types of corrective action when the action levels are exceeded, and up to three action levels are defined for each parameter (while only the normal operating value is provided in FSAR Tier 2, Table 5.2-2), in RAI 125, Question 09.03.04-18, the staff requested that the applicant provide additional information. In a December 5, 2008, response to RAI 125, Question 09.03.04-18, Parts 1, 2, 3, 4, and 5, the applicant identified and discussed the EPRI Primary Water Chemistry Guidelines as the reference document for parameters and frequency of sampling for the U.S. EPR designs The staff reviewed the response and finds Parts 1, 2, 3, and 5 acceptable. The staff confirmed that the change to reference the latest edition of the EPRI Primary Water Chemistry Guidelines was incorporated in Revision 1 of the FSAR Tier 2, Section 9.3.4.6. However, RAI 125, Question 09.03.04-18 is still unresolved. Accordingly, in follow-up RAI 492, Question 09.03.04-21 the staff requested that the applicant address the concerns of Part 4 response of operating the RCS hydrogen below the guidelines recommendation. Additionally, in follow-up RAI 492, Question 09.03.04-21, the staff also requested that the applicant provide a more rigorous technical evaluation of the hydrogen control range that demonstrates the acceptability of maintaining the RCS hydrogen below the EPRI Guidelines Action Level 1 limit.

FSAR Tier 2, Section 9.3.4 states that the reactor coolant pH will be maintained in the alkaline range but does not provide a range of pH values. Operation with pH on the alkaline side of neutral (7.1-7.3) is recommended by the EPRI PWR Primary Water Chemistry Guidelines. pH is not a control parameter under the EPRI PWR Primary Water Chemistry Guidelines. However, the guidelines recommend pH be optimized for each plant to minimize corrosion of RCS materials and fuel, and minimize corrosion product deposition. Minimizing corrosion also helps to control primary coolant activity, since most activity is the result of activation of corrosion products in the reactor core. Since pH is not a control parameter, the staff finds it acceptable that the applicant did not provide a numerical pH value, since the applicant stated that the water chemistry control parameters will be based on the EPRI Primary Water Chemistry Guidelines.

The U.S. EPR uses enriched boric acid for reactivity control. EBA is boric acid in which the boron is enriched in the ^{10}B isotope, which has a higher neutron absorption cross section than the ^{11}B isotope. The ^{10}B isotope constitutes only 20 percent of the boron in non-enriched boron. Therefore, a lower concentration of boric acid is required for the same amount of reactivity control as a higher concentration of non-enriched boric acid. Use of EBA allows lower lithium hydroxide concentrations to maintain pH. Higher (more alkaline) pH can thus be achieved resulting in reduced corrosion and corrosion product deposition in the RCS. The staff finds the use of EBA acceptable, because it allows a more alkaline pH that should reduce corrosion and deposition of corrosion products in the RCS.

The U.S. EPR uses lithium hydroxide for pH control with the lithium enriched in the ^{7}Li isotope. Use of ^{7}Li is preferred by PWRs for radiological purposes because it minimizes the amount of ^{6}Li available for conversion to tritium. Use of the ^{7}Li isotope does not reduce the effectiveness of pH control of the lithium hydroxide. The staff finds the use of lithium hydroxide (enriched in ^{7}Li) acceptable, because it conforms to accepted industry practice for operating units and will have radiological benefits. These chemicals also allow for more efficient processing of liquid radioactive waste as lower boron concentrations will make radionuclide removal by resins more effective.

The normal operating range for hydrogen of 17-28 cc/kg Standard Temperature and Pressure ((STP) specified for the U.S. EPR is lower than the specified range in the EPRI guidelines (25-50 cc/Kg (STP)). Therefore, in RAI 125, Question 09.03.04-18, the staff requested that the applicant clarify why a lower range of hydrogen concentration is specified for the reactor coolant than recommended in the EPRI guidelines. In a December 5, 2008, response to RAI 125, Questions 9.03.04-18, the applicant identified the EPRI Primary Water Chemistry Guidelines as the reference document for parameters and frequency of sampling for the U.S. EPR designs. The applicant further stated that recent research indicates that although there are advantages to higher hydrogen concentrations in the RCS, the disadvantages are:

- Increased hydrogen uptake by the fuel cladding, leading to embrittlement and possibly accelerated corrosion.
- Increased crud (Fe and Ni) buildup on fuel rods and an increased risk for crud-induced power shifts.
- Increased release of nickel from steam generator tubing and a corresponding increase in dose rates.
- Operational difficulties due to the higher hydrogen levels (e.g., charging pump cavitation).

To date, there have been no reports of these disadvantages occurring from any plants using hydrogen concentrations in the range of 35-50 cc/kg. The hydrogen concentration in the RCS is a control parameter associated with Action Level I lower limit of 25 cc/kg. One of the main purposes of maintaining significant hydrogen 'buffer' over a minimum hydrogen concentration is for mitigation of oxygen intrusion into the RCS. All make-up and borated water sources that provide direct feed to the RCS are saturated with oxygen. Thus, the lower limit of 25 cc/kg has been used to ensure that oxygen ingress, especially during intervals of large volume make-up, does not go unabated.

In RAI 492, Question 09.03.04-21, the staff requested that the applicant provide a more rigorous technical evaluation of this hydrogen control range that demonstrates why it is acceptable to maintain RCS hydrogen below the EPRI Guidelines Action Level 1 limit. **RAI 492, Question 09.03.04-21 is being tracked as an open item.**

The flow rate through the CVCS system is normally about 666 lpm (176 gpm) with a maximum flow rate of approximately 1060 lpm (280 gpm). This flow rate allows for a cleanup half-life of approximately 8.3 hours. This is an adequate measure for RCS cleanup from either radioactive or non-radioactive contaminants. The flow from the letdown heat exchangers is directed through a purification loop with two mixed bed demineralizers in parallel. Preceding the demineralizers are three 0.45 μm pre-filters, as shown in FSAR Tier 2, Figure 9.4.3-2. This is particularly small for a pre-filter size and generally should be 10 to 50 μm. Furthermore, the outlet of the demineralizers has a "resin trap" with an unspecified mesh size. This is of particular significance in that resin fines will pass through ordinary screens, and if allowed to enter the RCS, can lead to contaminant excursions. In a December 5, 2008, response to RAI 125, Question 09.03.04-13, the applicant identified that the filter size was not correctly noted. The staff has reviewed the proposed FSAR revision to this micron size in FSAR Tier 2, Table 9.3.4.1 and finds the change acceptable. The staff has confirmed that the change has been incorporated in Revision 1 of the FSAR and. therefore, considers RAI 125, Question 09.03.04-13 resolved.

As described in FSAR Tier 2, Section 9.3.4.2.1, and identified in FSAR Tier 2, Figure 9.3.4-2, Sheets 1 to 5, the coolant purification system of CVCS is stated to have a temperature bypass valve that is activated to by-pass the demineralizers should the letdown flow temperature exceed 65.5 °C (150 °F). This is about 16.7 °C (30 °F) higher than the temperature at which anion resins begin to measurably degrade.

In a December 5, 2008, response to RAI 125, Question 09.03.04-14, Part 1 states that 65.5 °C (150 °F) associated with protection of the coolant purification ion exchange resins will be changed to 60 °C (140 °F). The staff has reviewed the proposed FSAR revision to the maximum allowable temperature for the resins in FSAR Tier 2, Section 9.3.4.2.1 and finds the change acceptable. The staff has confirmed the change has been incorporated into Revision 1 of the FSAR and considers RAI 125, Question 09.03.04-14, Part 1 resolved.

In a December 5, 2008, response to RAI 125, Question 09.03.04-14, Parts 2 and 3, the applicant stated that the temperature bypass control for the demineralizer beds is upstream of the resins and shown on FSAR Tier 2, Figure 9.3.4-1, Sheet 2. The staff notes that, although some degradation of the resin could still occur at 60 °C (140 °F), the location of this temperature control sensor is sufficiently far upstream of the demineralizer beds to minimize the amount of excessively hot water that can reach the beds, thus providing adequate thermal protection. Therefore, the staff considers RAI 125, Question 09.03.04-14, Parts 2 and 3 resolved.

The CPS can also be supplied by the residual heat removal system for those times during outages when the reactor coolant pumps are not in service. Thus, the concentration of radioactive materials in the RCS can be maintained at acceptably low levels via constant cleanup using the CPS in compliance with GDC 33 and GDC °60.

CVCS also has a subsystem. The CDS described in the FSAR Tier 2, Section 9.3.4.2.1 maintains RCS hydrogen concentration by removing and adding hydrogen into the letdown flow, and removing noble gas fission products to the waste gas system. As part of this subsystem of CVCS, the volume control tank acts as both a surge volume for the letdown and mechanism for maintaining a constant gaseous atmosphere on RCS. Flow through the VCT is 10 percent of the total letdown flow. This is to ensure that the surge volume in the VCT is continually refreshed with the current RCS boron concentration. Such a design prevents inadvertent reactivity excursions resulting from a surge tank/RCS boron mismatch. The FSAR identifies that nitrogen gas flow in the VCT is used to maintain hydrogen concentration in the RCS in addition to the use of a hydrogen injector system currently in use in German PWRs. This is not a normal practice in current U.S. PWR’s in which full letdown flow is sprayed through the VCT gas phase to reach hydrogen saturation at the set-pressure. Use of nitrogen in the VCT during operation will lead to the formation of ammonia and other nitrogen compounds in the RCS (an undesirable condition). The exact mechanism of how nitrogen purging of the VCT maintains hydrogen concentration is not explained in the FSAR. The additional information regarding hydrogen control in the RCS was also requested in RAI 125, Question 09.03.04-16 Parts 1, 2 and 3. The applicant responded that the specific equipment function, the flow conditions and the equations that show how RCS hydrogen will be controlled will be identified later in the design process. The licensee also responded that the purpose of 10 percent letdown flow through the VCT was to maintain boron equilibrium between the VCT and the RCS and not to control hydrogen. In follow up RAI 200, Question 09.03.04-19, Parts 1, 2, and 3 and RAI 125, Question 09.03.04-16, Part 3, the staff requested that the applicant describe how nitrogen continuously purged through the VCT would prevent build up of ammonia and control hydrogen by this continuous nitrogen feed and bleed process in the RCS. The responses to Questions 1, 2a and b of RAI 200, Question 09.03.04-19 are impacted by this response as well. In a subsequent April 24, 2009, response to RAI 200, Question 09.03.04-19, the applicant stated:

> The hydrogen is collected in the top head of the gas separator and educted by the water jet pump and discharged into the letdown stream. The RCS hydrogen concentration depends on the hydrogen partial pressure in the gas separator and the back pressure applied to the gas by the over pressure maintained in the Volume Control Tank.

This response indicates that the measurement of hydrogen concentration will be based on the partial pressure in the gas separator and the VCT back pressure. However, both the VCT and the gas separator will also be saturated with nitrogen gas. The question of how the exact concentration of hydrogen will be determined is not evident in this explanation. Therefore, in RAI 492, Question 09.03.04-22, the staff requested that the applicant describe the exact mechanism of how nitrogen purging of the VCT maintains hydrogen concentration in the RCS and what equations would be used to determine the theoretical hydrogen concentration in the RCS. **RAI 492, Question 09.03.04-22 is being tracked as an open item.**

In the April 24, 2009, response to RAI 200, Question 09.03.04-19, Part 3, the applicant indicated that the equilibrium concentration of ammonia and its effect on demineralizer performance are to be provided at a future date (later in the design process). Therefore, in RAI 492, Question 09.03.04-23, the staff requested that the applicant describe how ammonia build up in the RCS will affect demineralizer performance. **RAI 492, Question 09.03.04-23 is being tracked as an open item.**

FSAR Tier 2, Section 9.3.4.2.1 describes the functioning of the two-demineralizer beds. One is normally in service and is lithiated prior to being put into service. The second mixed bed is in the hydrogen form and is used for removing lithium. However, the description identifies an unusual practice of potentially changing out the primary mixed bed resin when it is depleted, and using the second bed as the inservice demineralizer after it has been fully re-lithiated. This is not a common practice, as it would leave CVCS:

- Without any demineralization capability until the standby bed was fully lithiated
- Without a de-lithiating bed until the first bed was replaced which could take days

Such a delay in maintaining de-lithiating capability would cause a significant pH change in the RCS especially towards the beginning of the cycle. Therefore, in a December 5, 2008, response to RAI 125, Question 09.03.04-15, Parts 1 and 2, the applicant indicated that demineralizer resins will be purchased in the lithiated form. The information provided in response #1 to this RAI is contrary to what is stated in FSAR Tier 2, Section 9.3.4.2.1 of the licensee submittal. As indicated in the FSAR:

> Both ion exchangers are initially charged with the same quantity of resin in the form of H^+ and OH^-. One ion exchanger is saturated with lithium and boron. After an equilibrium concentration is reached, this ion exchanger serves as the main purification ion exchanger. The other ion exchanger removes cesium and excess lithium produced in the RCS.

In the December 5, 2008, response to RAI 125, Question 09.03.04-15, Parts 1 and 2, the applicant stated that the FSAR will not need to be changed. The staff notes that the discrepancy between the RAI response and the FSAR must be rectified. Therefore, in RAI 492, Question 09.03.04-24, the staff requested that the applicant change the FSAR Tier 2, Section 9.3.4.2.1 to match the December 5, 2008, response to RAI 125, Question 09.03.04-15, Parts 1 and 2. **RAI 492, Question 09.03.04-24, is being tracked as an open item**. In Part 3 of RAI 125, Question 09.03.04-15, the staff requested that the applicant provide documented evidence of the times of these actions so that it can be assured that lithium will be controlling RCS pH in the correct band. In a December 5, 2008, response to RAI 125, Question 09.03.04-15, Part 3, the applicant stated that the U.S. EPRs will follow the guidance put forth in Nuclear Energy Institute (NEI) 97-06 which relies on the EPRI PWR Primary Water Chemistry Guidelines for control of RCS pH. The staff finds the applicant's December 5, 2008, response to RAI 125, Question 09.03.04-15, Part 3 acceptable.

Except for the open items for RAI 492, Questions 09.03.04-21, 09.03.04-22, 09.03.04-23 and 09.03.04-24, the staff finds the CVCS complies with the requirements of GDC 14 by providing equipment capable of maintaining reactor coolant purity and material compatibility to reduce corrosion and, thus, reduce the probability of abnormal leakage, rapid propagating failure, or gross rupture of the reactor coolant pressure boundary. The staff also finds the proposed water chemistry program acceptable, because it is consistent with industry guidelines for control of the allowable ranges for primary coolant activity, total dissolved solids, pH, and maximum allowable oxygen and halide concentrations.

GDC 29 identifies one function of the CVCS as to reliably provide negative reactivity to the RCS in the form of the proper boron concentration. A portion of the CVCS, the CSSS, has the capability of supplying recycled boric acid solution to the RCS. This is described in FSAR Tier 2, Section 9.3.4.2.1 "Reactor Makeup and Inventory Control." The six coolant storage tanks provide surge volume and RCS makeup during periods of changing RCS volume. These CSSS tanks are initially used as dilution water for the boric acid storage tank water so that makeup to the RCS of appropriate boron concentration can be made. This is done by measuring the charging line boron concentration using four Am/Be neutron generators with a neutron detector, as described in FSAR Tier 2, Section 9.3.4.2.3.4. The measured boron concentration is used to signal the proper mixing of dilution water with borated water storage tank liquid so that there will be no reactivity excursions resulting from boron mismatch. The CSSS tanks are used later in core life to recover diluted RCS (from letdown that is diluted to maintain reactor power) through the CTS. The CTS recovers boron and water via evaporation. The theory behind this evaporative technique is not new; however, U.S. plants have not been able to implement successfully this type of recovery system due to the concentration of contaminants in the recovered borated water concentrate. No new techniques for avoiding this contaminant issue are provided in the FSAR. Additionally, the functional details of how the mixing of boric acid for auto makeup to the RCS are not described. The applicant's December 5, 2008, response to RAI 125, Question 09.03.04-17, Parts 1 and 2 described the general functioning of the evaporator and purification system for boron recovery. Additional information regarding the evaporator system was provided to the same question in RAI 125, Question 09.03.04-17. The applicant stated that the effluent from the evaporator system is passed through a mixed bed demineralizer to remove and ionic contaminants that may carry over during the evaporation process. The applicant also noted in the December 5, 2008, response to RAI 125, Question 09.03.04-17:

> …the boron concentration detectors are located on the charging line, upstream of the branch line to the seal water to measure the concentration of the total

charging flow. Additionally, this section describes how the detectors measure B-10 concentration. U.S. EPR FSAR, Tier 2, Section 7.3.1.2.11 states that an online calculation of the boron concentration in the reactor coolant system (RCS) is performed during power operation based on the boron concentration measurement in the chemical volume control system (CVCS) charging line and the measured CVCS charging flow. The section also addresses the mitigation of risk of RCS boron concentration dilution.

In follow-up RAI 200, Question 09.03.04-20, the staff requested that the applicant perform a pre-operational functional test of the evaporator system to demonstrate its capabilities. In an April 24, 2009, response to RAI 200, Question 09.03.04-20, the applicant stated that such a test "will be requested as part of the supplier's functional shop testing (or equivalent) prior to owner equipment acceptance and release for shipment (to the site)." Therefore in RAI 492, Question 09.03.04-25, the staff requested that the applicant describe the pre-operation functional test of the evaporator system in the FSAR. **RAI 492, Question 09.03.04-25 is being tracked as an open item.**

In RAI 200, Question 09.03.04-20, the staff also requested that the applicant provide a calculation that demonstrates that the B-10 concentration will not be depleted during the 1 year interval between confirmative analytical results while water is being reprocessed. In an April 24, 2009, response to RAI 200, Question 09.03.04-20 the applicant replied that, "frequency for determining the B-10 assay (atom %) will be identified later in the design process." Therefore, in RAI 492, Question 09.03.04-26, the staff requested that the applicant describe the method for determining the B-10 assay frequency in the FSAR. **RAI 492, Question 09.03.04-26 is being tracked as an open item.**

Except for the items discussed in Open Items RAI 492 Questions 09.03.04-25 and 09.030.4-26, the staff finds the applicant's response to RAI 125, Question 09.03.04-17 and RAI 200, Question 09.03.04-20 acceptable.

9.3.4.5 *Combined License Information Items*

FSAR Tier 2, Table 1.8-2, "U.S. EPR Combined License Information Items, has no COL information items for Section 9.3.4.

9.3.4.6 *Conclusions*

9.3.4.6.1 Systems Aspects

The staff finds the design of the chemical and volume control system acceptable and complies with GDC 1, GDC 2, GDC 29, GDC 60, GDC 61, 10CFR 50.34(f)(2)(xxvi), 10 CFR 50.63, and 10 CFR 52.47(b)(1). This evaluation did not include chemistry aspects of the CVCS and, therefore, no conclusions were reached with regard to GDC 14.

9.3.4.6.2 Chemistry Aspects

The CVCS and its subsystems (CSSS, CTS, CDS) are identified with necessary components that provide the functionality required to support chemical control to maintain the RCPB intact, provide radiation protection by minimizing the activity of processed fluids, and adjust boron concentration for reactivity control.

Except for the open items in RAI 492, Questions 09.03.04-21, 09.03.04-22, 09.03.04-23, 09.03.04-24, 09.03.04-25, and 09.03.04-26, the staff concludes the chemical volume and control system complies with the requirements of GDC 14, GDC 29, GDC 33, GDC 60, GDC 61 and the recommendations in NUREG-0800, Section 9.3.4.

No ITAAC requirements relating to chemistry were identified in FSAR Tier 1, Section 2.2.6. The Technical Specification requirements are described in FSAR Tier 2, Section 16, Surveillance Requirement 3.4.15. The staff finds the design of the CVCS adequate to maintain the RCS within the bounds of the specific activity requirements in this Technical Specification under normal operating conditions.

9.4 Air Conditioning, Heating, Cooling and Ventilation Systems

The heating, ventilation, and air conditioning system (HVAC) for each major building or area is provided in the following subsections.

9.4.1 Main Control Room Air Conditioning System

9.4.1.1 *Introduction*

The main control room air conditioning system (CRACS) is designed to maintain a controlled environment in the control room envelope (CRE) area and provides a controlled environment for the comfort and safety of control room personnel and assures the operability of control room components during normal operating, anticipated operational transient, and design-basis accident conditions. CRACS is also relied upon to ensure coping with and recovering from a station blackout event.

9.4.1.2 *Summary of Application*

FSAR Tier 1: The FSAR Tier 1 information associated with this section is found in FSAR Tier 1, Revision 2, Section 2.6.1, “Main Control Room Air Conditioning System.”

FSAR Tier 2: The applicant has provided a system description in FSAR Tier 2, Revision 2, Section 9.4.1, “Main Control Room Air Conditioning System,” summarized here, in part, as follows:

The CRACS is designed to maintain acceptable ambient conditions inside the CRE areas to provide for proper operation of equipment and for personnel access to conduct inspections, testing, and maintenance. The MCR habitability system, including the definition of the CRE is addressed in Section 6.4 of this report. FSAR Tier 2, Section 6.4, Figures 6.4-1, “Control Room Envelope Plan View 1,” 6.4-2, “Control Room Envelope Plan View 2,” and 6.4-3, “Control Room Envelope Elevation View,” show the CRE area. FSAR Tier 2, Section 6.4.2.1 includes the Technical Support Center (TSC) as part of the CRE. The staff evaluation of the TSC habitability is addressed in Section 6.4 of this report.

ITAAC: The ITAAC associated with FSAR Tier 2, Section 9.4.1 are given in FSAR Tier 1, Section 2.6.1.

Technical Specifications: The Technical Specifications associated with FSAR Tier 2, Section 9.4.1 are given in FSAR Tier 2, Chapter 16, Sections 3.7.10, “Control Room Emergency Filtration (CREF),” and 3.7.11, “Control Room Air Conditioning System (CRACS).”

Initial Plant Test Program: The initial plant test program summary description for the CRACS is given in FSAR Tier 2, Section 14.2.8.12.10, "Main Control Room Air Conditioning System (Test No. 082)."

9.4.1.3 *Regulatory Basis*

The relevant requirements of NRC regulations for this area of review, and the associated acceptance criteria, are given in NUREG-0800, Revision 3, Section 9.4.1, "Control Room Area Ventilation System," and are summarized below. Review interfaces with other SRP sections also can be found in NUREG-0800, Section 9.4.1.

1. GDC 2, as it relates to system capability to withstand the effects of earthquakes.

2. GDC 4, as it relates to the CRACS being appropriately protected against dynamic effects and being designed to accommodate the effects of, and to be compatible with, the environmental conditions of normal operation, maintenance, testing, and postulated accidents.

3. GDC 5 indicates that sharing a SSC between multiple units will not significantly impair the SSC's ability to perform its safety function in the event one unit experiences an accident condition.

4. GDC 19, "Control Room," as it relates to providing adequate protection to permit access to and occupancy of the control room under accident conditions.

5. GDC 60, as it relates to system capability to suitably control release of gaseous radioactive effluents to the environment.

6. 10 CFR 50.63, as it relates to necessary support systems providing sufficient capacity and capability to ensure the capability for cope with a station blackout event.

7. 10 CFR 52.47(b)(1), which requires that a design certification application contain the proposed inspections, tests, analyses, and acceptance criteria that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a plant that incorporates the design certification is built and will operate in accordance with the design certification, the provisions of the Atomic Energy Act of 1954, and NRC regulations.

Acceptance criteria adequate to meet the above requirements include:

1. For GDC 2, the CRACS should be consistent with the guidance of RG 1.29, "Seismic Design Classification," Revision 4, March 2007, Regulatory Position C.1, for safety-related portions and Regulatory Position C.2 for non-safety-related portions.

2. For GDC 4, the CRACS should be consistent with the acceptance criteria of NUREG-0800, Sections 3.5.1.1, "Internally Generated Missiles (Outside Containment)"; 3.5.1.4, "Missiles Generated by Tornadoes and Extreme Winds"; 3.5.2, "Structures, Systems, and Components to be Protected from Externally-Generated Missiles"; and 3.6.1, "Plant Design for Protection Against Postulated Piping Failures in Fluid Systems Outside Containment."

3. For GDC 5, acceptance is based on the determination that sharing of CRACS structures systems and components in multiple-unit plants does not significantly impair their ability to perform their safety functions, including, in the event of an accident in one unit, an orderly shutdown and cooldown of the remaining unit(s).

4. For GDC 19, the CRACS should be consistent with the guidance of RG 1.78, "Evaluating the Habitability of a Nuclear Power Plant Control Room during a Postulated Hazardous Chemical Release," Revision 1, December 2001.

5. For GDC 60, CRACS should be consistent with the guidance of RG 1.52, "Design, Testing, and Inspection Criteria for Air Filtration and Adsorption Units of Post-Accident Engineered-Safety-Feature Atmosphere Cleanup Systems in Light-Water-Cooled Nuclear Power Plants," Revision 3, June 2001, and RG 1.140, "Design, Inspection, and Testing Criteria for Air Filtration and Adsorption Units of Normal Atmosphere Cleanup Systems in Light-Water-Cooled Nuclear Power Plants," Revision 2, June 2001.

6. For 10 CFR 50.63, CRACS should be consistent with the guidance of RG 1.155, "Station Blackout," August 1988, including Regulatory Position C.3.2.4.

7. For 10 CFR 52.47(b) (1), CRACS should be consistent with the guidance of RG 1.206, Section C.II.1, "Inspections, Tests, Analyses, and Acceptance Criteria," and that contained in SRP Section 14.3, "Inspections, Tests, Analyses, and Acceptance Criteria," and 14.3.7, "Plant Systems-Inspections, Tests Analyses and Acceptance Criteria.."

8. For 10 CFR 20.1406, CRACS should be consistent with the guidance of RG 4.21, "Minimization of Contamination and Radioactive Waste Generation: Life-Cycle Planning."

9.4.1.4 *Technical Evaluation*

The staff reviewed the FSAR and supporting Tier 2 information in accordance with NUREG-0800, Section 9.4.1, Section III, and Review Procedures. The staff's review results and conclusions reached are as follows:

The main control room air conditioning system consists of the following subsystems:

- Air intake
- CREF (Iodine filtration train)
- Air Conditioning and Recirculation air handling
- CRE Air supply and recirculation
- Kitchen and rest rooms exhaust

The staff's review is based on the design presented in FSAR Tier 1, Section 2.6.1 and FSAR Tier 2, Revision 2, Section 9.4.1, as modified by the December 2008, and February 2009, responses to RAI 135, Revision 0 and Supplement 1 and the October 2009, through May 2011, responses to RAI 277, Revision 0 and Supplements 1 through 17.

Air Intake Subsystem

Safeguard Building Divisions 2 and 3 each have a fresh air intake that supplies outside air. Each outside air intake is equipped with an electrically heated, weather-protected grille to prevent ice formation. The design utilizes one fresh air intake train per division (total of two trains). The fresh air trains are physically separated. Each train consists of a fire damper, motorized fresh air inlet isolation damper, motorized pressure control damper, motorized pre-filter inlet isolation damper, pre-filter located upstream of the electric heater, and motorized outlet isolation damper. Fresh air is then mixed with the recirculated air from the CRE area prior to conditioning by the air handling units. The design includes a sensor installed in each outside air intake to protect against toxic gas, and smoke and radiation monitors are installed in the outside air intake ducting.

CREF (Iodine Filtration Train) Subsystem

For each intake train, a 100 percent capacity iodine filtration train is located in parallel, but separated, from the associated intake trains. The iodine filtration train provides an alternate path for fresh air intake and CRE recirculated air when site contamination is detected. Each iodine filtration train consists of an inlet motorized isolation damper, prefilter, electric heater, upstream high efficiency particulate air (HEPA) filter, iodine filter with activated carbon, downstream HEPA filter, outlet motorized isolation damper, supply air fan, and backdraft damper. The motorized dampers operate automatically to isolate or align the iodine filtration trains. Under emergency conditions, when the iodine filtration train subsystem of CRACS is utilized, the subsystem function is designated as control room emergency filtration.

Air Conditioning and Recirculation Air Handling Subsystem

There are four 75 percent capacity recirculation air handling units located in Safeguard Building 2 and 3 (two trains for each building). Recirculated and fresh air is processed through these air handling units and supplied to a common supply air plenum. Each train includes an isolation damper, volume control manual damper, cooling coil, moisture separator, fan suction and discharge silencers, supply air fan, HEPA filter, non-return damper, The cooling coil is supplied with chilled water from the safety chilled water system (SCWS). During normal operation, two 75 percent capacity recirculation trains operate to maintain the following temperature ranges:

Room	Temperature	Humidity
Main Control Room:	20 °C to 25.6 °C (68 °F to 78 °F)	30-60%
I&C Computer Rooms, Rest Rooms:	18.3 °C to 25.6 °C (65 °F to 78 °F)	30-60%
HVAC Rooms:	10 °C to 35°C (50 °F to 95 °F)	30-60%
Other areas of CRE:	18.3 °C to 26.1 °C (65 °F to 79 °F)	20-80%

CRE Air Supply and Recirculation Subsystem

The common supply air plenum receives air from the operating CRACS air handling units and provides conditioned air to any of the CRE areas through the ductwork distribution network. Electric air heaters are installed in the supply air ducts to maintain individual room temperatures. Except the exhaust from kitchen and restrooms rooms, the exhaust air from the CRE area is recirculated through the recirculation air handling units. The exhaust from kitchen and restrooms is processed separately through the Electrical Division of Safeguard Building Ventilation System (SBVSE).

The CRACS maintains a positive pressure in the CRE areas relative to the outside environment and adjacent areas. The fresh air flow rate corresponds to the exhaust of kitchens and restrooms and the leakage rate in the CRE area due to controlled overpressure.

Upon receipt of containment isolation signal, or high radiation alarm signal in the air intake duct, the CREF (iodine filtration) train will start automatically, and outside air supply to the CRE area is diverted through the iodine filtration train.

Upon actuation of the plant toxic gas alarm signal, audible and visual alarms are actuated in the MCR. The CREF (iodine filtration) units on both intakes are automatically placed in the filtered alignment. The outside air intake (at the location where the toxic gas is detected) is manually closed by the control room operator.

In FSAR Tier 2, Section 9.4.1.1, "Design Bases," the applicant states that with the exception of the restroom/kitchen exhaust fan and smoke detectors, all CRACS components are safety-related and designed to Seismic Category I. The restroom/kitchen exhaust fan, smoke detectors are non-safety-related NS-QA and Seismic Category II. The CRACS components are designed and tested to ASME AG-1-2003, "Code on Nuclear Air and Gas Treatment," as shown in FSAR Tier 2, Table 3.2.2.1, "Classification Summary," Sheets 156 through 186. The staff finds this follows the guidance of RG 1.52, and is therefore acceptable.

GDC 2, Natural Phenomena

In FSAR Tier 2, Section 9.4.1.1, the applicant stated that the system is designed to Seismic Category I per RG 1.29, Regulatory Position C.1 for safety-related components and Regulatory Position C.2 for non-safety-related components. FSAR Tier 2, Figures 9.4.1-1, "Control Room Air Intake and Iodine Filtration Train Subsystems," through 9.4.1-3, "Control Room Envelope Air Supply and Recirculation Subsystem," clearly identify the breaks between Seismic Category I and II portions of the system. However, FSAR Tier 2, Tables 3.2.2-1, "Classification Summary," and 3.11-1, "List of Environmentally Qualified Electrical/I&C Equipment," indicate that the some of the CRACS fire dampers are Non-Safety, Supplemented Grade (NS)-AQ and designed to Seismic Category II requirements. FSAR Tier 2, Figures 9.4.1-1 through Figures 9.4.1-3 indicate that in addition to fire dampers, portions of the air intake, CRE supply and exhaust ducts are designed to Seismic Category II requirements. The Seismic Category II classification of the fire dampers and associated ductwork in the CRACS air intake, CRE supply and exhaust ducts provides for a common mode failure of all CRACS divisions if a safe-shutdown earthquake (SSE) or larger seismic event occurs. Therefore, in RAI 135, Question 09.04.05-1 (#1), and in RAI 277, Question 09.04.01-1 (#3) the staff requested that the applicant reconcile the conflicts in safety and seismic classification.

In a February 27, 2009, response to RAI 135, Questions 09.04.05-1 (#1) and Question 09.04.01-1 (#3), and in a July 28, 2010, response to RAI 277, Question 09.04.01-1, the applicant indicated that the statements regarding the seismic classification of CRACS fire dampers, ductwork, and electric heaters have been reconciled and provided proposed revisions to FSAR Tier 1, Figures 2.6.1-1, "Main Control Room Air Conditioning System Equipment Mechanical Design"; 2.6.1-2, "Main Control Room Air Conditioning System Equipment I&C and Electrical Design"; and 2.6.1-3, "Main Control Room Air Conditioning System ITAAC"; FSAR Tier 2, Figures 9.4.1-1, 9.4.1-2, "Control Room Recirculation Air Handling Subsystem"; and 9.4.1-3; FSAR Tier 2, Tables 3.2.2-1; 3.10-1, "List of Seismically and Dynamically Qualified Mechanical and Electrical Equipment"; and 3.11-1; and FSAR Tier 2, Section 9.4.1.1. With these revisions, all components of CRACS, except for the restroom/kitchen exhaust fan and smoke detectors are designated safety-related and Seismic Category I. The staff confirmed that these FSAR revisions are incorporated in FSAR Revision 2, and finds them acceptable since appropriate safety-related components were identified. Based on the above, the applicant's response, and the FSAR revision, the staff considers RAI 135, Questions 9.4.5-1 (#1) and Question 09.04.01-1 (#3) resolved.

The staff finds the design of the CRACS complies with the requirements of GDC 2 regarding protection from the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, floods, and external missiles as follows. The CRACS components are located inside the Safeguard Building Divisions 2 and 3. The Safeguard Buildings are Seismic Category I designed structures that are also located and designed to provide protection from flood, hurricane/tornado winds, and missiles. FSAR Tier 2, Sections 3.3, "Wind and Tornado Loadings"; 3.4, "Water Level (Flood) Design"; 3.5, "Missile Protection"; 3.7, "Seismic Design"; and 3.8, "Design of Category I Structures," provide the bases for the adequacy of the structural design of these buildings with respect to natural phenomena.

GDC 4, Dynamic Effects

GDC 4 requires that structures, systems, and components important to safety are designed to accommodate the effects of and to be compatible with the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents, including loss-of-coolant accidents. The staff evaluated whether the CRACS meets the requirements of GDC 4.

As stated in FSAR Tier 2, Section 9.4.1, the environmental and dynamic effects of internal and external missiles and postulated piping failures on the CRACS are addressed in FSAR Tier 2, Sections3.5.1.1, 3.5.2, and 3.6.1.

The staff reviewed the locations of CRACS components as described in FSAR Tier 2, Chapter 3, "Design of Structures, Components, Equipment, and Systems." The CRACS is located inside the Safeguard Building divisions two and three. In regard to physical separation of system trains, FSAR Tier 2, Section 9.4.1.2.1 provides the following:

- The two air fresh air intake trains are physically separated and one is located in each of the Safeguard Building Divisions 2 and 3.
- The two iodine filtration trains located separately in the Safeguard Building Divisions 2 and 3 (one train in each division) are in parallel with the associated air intake trains.
- The four recirculation air handling units are located in the Safeguard Building Divisions 2 and 3 (two trains in each division).

Each of the two divisions is physically separated in separate buildings; however, it was not clear from the applicant's description if:

1. Recirculation air handling units in each division are physically separated.
2. The iodine filtration trains are physically separated from the parallel associated intake train.

Therefore, in RAI 135, Question 09.04.05-1 (#2 Items 1 & 2), the staff requested that the applicant clarify the physical separation of the CRACS division trains.

In a February 27, 2009, response to RAI 135, Question 09.04.05-1 (#2 Items 1 & 2), the applicant clarified that the recirculation air handling unit in each division (train) is physically separated. Each air handling unit has an interconnecting duct to pull air from a common recirculation plenum and supply air to a common supply plenum. Each recirculation air handling unit has a check damper at the fan exhaust to isolate the air handling unit when not in operation. The recirculation air handling unit also has an inlet damper (manually operated) to isolate the unit when in maintenance. The applicant stated that FSAR Tier 2, Section 9.4.1.2.1, "General Description - Recirculation Air Handling Subsystem and the Air Supply and Recirculation Subsystem," will be revised for clarity to indicate that the recirculation supply plenums are open between all four CRACS units.

The applicant also clarified that the CREF iodine filtration units in both trains 1 and 4 are also physically separated. FSAR Tier 2, Section 9.4.1.2.1 (Iodine Filtration Train Subsystem) was revised to clarify the system design. The staff has confirmed that these FSAR revisions were incorporated into FSAR Revision 2 and finds them acceptable because they clarify the description of the physical separation of the CRACS control room emergency filtration and recirculation trains. Based on the above, the applicant's response, and the FSAR revision, the staff finds that RAI 135, Question 09.04.05-1 (#2 Items 1 & 2) resolved

In FSAR Tier 2, Chapter 16, Technical Specification B 3.7.11, "Control Room Air Conditioning System (CRACS)," the applicant stated that with one division out of service for maintenance and a second lost to single failure, the two operable CRACS trains maintain the MCR temperature. However, if both trains in a division are lost, the P&ID (FSAR Tier 2, Figure 9.4.1-3) shows no supply air flow to half the CRE areas. Therefore, in RAI 135, Question 09.04.05-1 (#2, Item 4), the staff requested that the applicant verify that the design temperature is maintained throughout the MCR with both trains in a division out of service.

In a February 27, 2009, response to RAI 135, Question 09.04.05-1 (#2 Item 4), the applicant stated that it had modified the system design such that the supply plenum located in Safeguard Building 2 is interconnected and opens to the supply plenum located in Safeguard Building 3. Likewise, the recirculation plenum located in Safeguard Building 2 is interconnected and open to the recirculation plenum located in Safeguard Building 3. This modification allows any two of the four CRACS air handling units to supply all the CRE rooms. The applicant proposed revisions to FSAR Tier 1, Figures 2.6.1-2, and 2.6.1-3 and FSAR Tier 2, Figures 9.4.1-2 and 9.4.1-3 to reflect the system modifications. The staff has confirmed that these FSAR revisions were incorporated into FSAR Revision 2 and finds them acceptable because they ensure that all CRE areas would receive air flow in the event of loss of two trains in the same division. Based on the above, the applicant's response, and the FSAR revision, the staff considers RAI 135, Question 09.04.05-1 (#2 Item 4) resolved.

In the event of a loss of offsite power, the following emergency diesel generator (EDG) divisions provide power:

- EDG Division 1
    - Division 2 Air Recirculation Train 01
    - Division 2 Air Iodine Filter Train 01
- EDG Division 2
    - Division 2 Air Recirculation Train 02

- EDG Division 3
    - o Division 3 Air Recirculation Train 03
- EDG Division 4
    - o Division 3 Air Recirculation Train 04
    - o Division 3 Air Iodine Filter Train 04

The Fresh Air Intake trains obtain power from:

- Fresh Air Intake Train 01
    - o EDG Division 1
        - ▪ Fresh Air Volume Control Damper (30SAB01AA012)
        - ▪ Fresh Air Prefilter Inlet Damper (30SAB01AA003)
        - ▪ Fresh Air Heater
    - o EDG Division 1
        - ▪ Fresh Air Prefilter Outlet Damper (30SAB01AA004)
    - o EDG Division 4
        - ▪ Fresh Air Inlet (30SAB01AA002)
- Fresh Air Intake Train 04
    - o EDG Division 1
        - ▪ Fresh Air Inlet (30SAB04AA002)
    - o EDG Division 4
        - ▪ Fresh Air Prefilter Outlet Damper (30SAB04AA004)
    - o EDG Division 4
        - ▪ Fresh Air Volume Control Damper (30SAB04AA012)
        - ▪ Fresh Air Prefilter Inlet Damper (30SAB04AA003)
        - ▪ Fresh Air Heater

The worst case loss of an EDG (either Division 1 or 4) will cause the loss of both air intake trains, a recirculation train, and one iodine filtration train. The remaining trains have sufficient capacity to mitigate the accident. Fresh air makeup can be restored by manual alignment of the air intake dampers. However, it was unclear to the staff that the operating iodine filter train has the ability to clean up the atmosphere in the rooms serviced by the opposite train. Therefore, in

RAI 135, Question 09.04.05-1 (#3 Item d), the staff requested that the applicant verify adequate atmospheric cleanup of all CRE rooms when one iodine filtration train is out of service.

In a February 27, 2009, response to RAI 135, Question 09.04.05-1 (#3 Item d), the applicant indicated that it had modified the system design (as discussed previously) to interconnect the recirculation plenums of Safeguard Building Divisions 2 and 3. This allows the operating iodine filter train to clean the atmosphere from all of the CRE rooms. The staff finds this response acceptable.

The applicant states that the CRACS is located inside the Safeguard Building that is designed to withstand the effects of natural phenomena, such as earthquakes, tornados, hurricanes, floods, and external missiles (FSAR Tier 2, Sections 3.5.1.4, "Missiles Generated by Tornadoes and Extreme Winds," 3.5.2, "Structures, Systems, and Components to be Protected from Externally Generated Missiles,"). The equipment is not located in an area with high-energy lines. FSAR Tier 2, Table 3.11-1 shows the electrical equipment is located in a mild environment and, therefore, not subject to environmental qualification.

The staff concludes the design of the safety-related portions of the CRACS complies with the requirements of GDC 4 regarding potential dynamic effects, such as pipe whip, jet impingement, and missile impacts caused by equipment failure or events outside the plant.

The CRACS is designed such that failure of non-safety-related equipment does not compromise or otherwise damage safety-related equipment. Based on the above, the staff finds that the CRACS complies with the requirements of GDC 4.

GDC 5, Shared Systems and Components Important to Safety

The staff reviewed the design of the CRACS to ensure that the relevant requirements of GDC 5 are met.

GDC 5 governs the sharing of structures, systems, and components important to safety among nuclear power plant units in order to ensure such sharing will not significantly impair their ability to perform their safety functions. The U.S. EPR design is a single-unit station, and the requirements of GDC 5 are not applicable to the single-unit design.

GDC 19, Control Room Access and Occupancy

The CRACS will maintain control room habitability in the event of release of airborne contamination that may enter the control room via the intake vents. In FSAR Tier 2, Section 9.4.1.1, the applicant states that in the event of a high radiation alarm signal in the air intake duct, the iodine filtration train starts automatically, and the outside air and CRE recirculation air are automatically diverted through the iodine filtration train. However, a review of the system identified that the loss of a fan in either of the Division 2 or 3 iodine filter trains following a design-basis accident will severely limit the ability to clean up any airborne contamination that occurs in the rooms serviced by that train. Although the opposite train is assumed to function, the airflows in and out of each room are balanced, thereby minimizing any mixing between rooms. Therefore, in RAI 135, Question 09.04.05-1 (#3, Item d), the staff requested that the applicant verify adequate atmospheric cleanup of all CRE rooms when one iodine filtration train is out of service. The staff finds the applicant's February 27, 2009, response to RAI 135, Question 09.04.05-1 (#3, Item d) acceptable and is discussed in the GDC 4 paragraph above.

The staff's review of the system also identified that there is only a single exhaust path from each of the rooms within the CRE, except the computer room. Assuming a single active failure causes a motorized fire damper to fail closed, that room would experience a significant reduction of supplied conditioned air. After some period, it would be expected the room design temperature would be exceeded. Therefore, in RAI 135, Question 09.04.05-1 (#3 Item e), the staff requested that the applicant verify adequate temperature and humidity control in the CRE rooms when an exhaust path is out of service.

In a February 27, 2009, response to RAI 135, Question 09.04.05-1 (#3 Item e), the applicant stated that the fire dampers in the return air ducting were incorrectly shown as having motor operators. All components in the CRE return air ducting are passive components and are not subject to a single active failure. The applicant proposed a revision to FSAR Tier 2, Figure 9.4.1-3 to correctly show the fire dampers. The staff finds the proposed revision acceptable. The staff has confirmed that these FSAR revisions were incorporated into FSAR Revision 2 and finds them acceptable because they eliminated a design feature that caused the exhaust pathways to be subject to single active failure. Based on the above, the applicant's response, and the FSAR revision, the staff considers RAI 135, Question 09.04.05-1 (#3 Item e) resolved.

The review identified that there is only a single isolation damper between the potentially contaminated inlet air and the recirculation train. When the CRACS system realigns for high radiation in the air inlet, a single failure of damper 30SAB01AA003 or 30SAB04AA003 to close provides a potential path for airborne contamination around the iodine filtration train. Therefore, in RAI 135, Question 09.04.05-1 (#3 Item f), the staff requested the applicant verify that an iodine filtration train is not bypassed in the event of a damper single failure.

In a February 27, 2009, response to RAI 135, Question 09.04.05-1 (#3 Item f), the applicant stated that due to the identified single-failure concern; the design was changed to add a second CREF unfiltered bypass duct motor operated isolation damper (30SAB01AA004 or 30SAB04AA004) for each of the CREF iodine filter units.

The applicant revised FSAR Tier 2, Figure 9.4.1-1 and FSAR Tier 1, Figure 2.6.1-1 to show a second motor operated isolation damper in the CREF unfiltered bypass ducting. The staff has confirmed that the FSAR revisions were incorporated into FSAR Revision 2 and finds it acceptable because it eliminated a design feature that caused the CREF trains to be subject to single active failure. Based on the above, the applicant's response, and the FSAR revision, the staff considers RAI 135, Question 09.04.05-1 (#3 Item f) resolved.

In RAI 509, Question 09.04.01-6, the staff requested that the applicant clarify the FSAR Tier 1 mark up provided with the response to RAI 277 Question 09.04.01-1. The June 30, 2011 response to RAI 277, Question 09.04.01-1 deleted the design function for the automatic start of the CREF train in response to a high radiation alarm signal from a radiation detected in an CRE intake duct. The description of this design function is described in FSAR Tier 2, paragraph 6.5.1.3. **RAI 509, Question 09.04.01-6 is being tracked as an open item.**

The CRACS components are designed and tested to ASME AG-1-2003, "Code on Nuclear Air and Gas Treatment," as shown in FSAR Tier 2, Table 3.2.2.1, "Classification Summary," Sheets 156 through 186. The staff finds that this follows the guidance of RG 1.52, and is therefore acceptable, except for RAI 462, Question 06.05.01-6, discussed in Chapter 6 of this report.

Control Room habitability in the event of a toxic gas release

The applicant's statement in FSAR Tier 2, Section 9.4.1.2 regarding the system response to an external fire, external toxic gas release, smoke, or excessive concentration of CO and CO_2 was not clear. The applicant stated that outside air to the CRACS is isolated manually or automatically, and the system operates in full recirculation mode without fresh air. Therefore, in RAI 135, Question 09.04.05-1 (#3 Item b), the staff requested that the applicant clarify under what conditions CRACS is isolated manually and under what conditions automatic isolation occurs.

In a February 27, 2009, response to RAI 135, Question 09.04.05-1 (#3 Item b), the applicant revised FSAR Tier 2, Section 9.4.1.2.3, to clarify the reaction of the system to the receipt of external fire, external toxic gas release, smoke or excessive concentrations of CO and CO_2. The CO and CO_2 monitoring has been added to the function of the toxic gas monitor.

FSAR Tier 2, Revision 2 Section 9.4.1.1 states that upon receipt of a toxic gas alarm from a toxic gas sensor in the outside air intake duct, the CREF (iodine filtration) trains are placed in the filtered alignment mode and the CRE air is diverted to the recirculation mode on both trains. The outside air inlet isolation damper at the outside inlet in alarm will be closed by the control room operator.

Closure of the outside air damper at the site of the toxic gas event continues to allow the CRE area to meet environmental habitability requirements. Therefore, staff finds the February 27, 2009, response to RAI 135, Question 09.04.05-1 (#3 Item b), and the FSAR revision acceptable.

In FSAR Tier 2, Section 9.4.1.1, the applicant states that CRACS conforms to the control room occupancy protection guidance of RG 1.78.

RG 1.78 provides guidelines for evaluating the habitability of a nuclear power plant control room during a postulated hazardous chemical release. FSAR Tier 2, Section 6.4.4 addresses these guidelines by including COL Information Item 6.4-3, which states that the COL applicant will determine the protective measures to be instituted to ensure adequate protection for control room operators as recommended under RG 1.78. These protective measures include features to (1) provide capability to detect releases of toxic or hazardous materials, (2) isolate the control room if there is a release, (3) make the control room sufficiently leak tight, or (4) provide equipment and procedures for ensuring the use of breathing apparatus by the control room operators. The staff finds this acceptable as it relates to the CRACS since COL Information Item 6.4-1 includes provisions to determine the types of Seismic Category 1 Class 1E toxic gas sensors necessary for control room operator protection, COL Information Item 6.4-2 includes provisions for procedures and training of control room personnel and COL Information Item 6.4-3 includes provisions to determine protective measures relating to isolating the control room or making the control room sufficiently leak tight.

During the review of FSAR Tier 2, Revision 2, the staff noted that the third paragraph in FSAR Tier 2, Section 9.4.1.2.3, "Abnormal operating conditions," section has been changed. The described response of the CRACS to a toxic gas event is different from that described in the previous revision of the FSAR and the applicant's February 27, 2009, response to RAI 135, Question 09.04.05-1 (#3 Item b). Therefore, in RAI 461, Question 09.04.01-5, the staff requested that the applicant clarify these FSAR Revision 2 changes. Specifically, the staff requested that the applicant clarify what toxic gas sensor design functions and design features are to be reviewed by the staff in the design certification, considering COL Information Items 6.4-1, 6.4-2, and 6.4-3, where a COL applicant is to provide this information. **RAI 461, Question 09.04.01-5, is being tracked as an open item.**

Accordingly, except for the above open items, the staff finds that a COL applicant that references the U.S. EPR design certification is to address the guidelines of RG 1.78 as it applies to the design of the CRACS to identify and mitigate toxic gas. Additional staff findings with respect to control room habitability in the event of an external toxic gas release are provided in Section 6.4 of this report.

Control Room habitability in the event of an external smoke release

Similarly, FSAR Tier 2, Section 6.4 describes the CRACS control room habitability objective to detect and protect personnel from external fires and smoke. FSAR Tier 2, Section 6.4 provides a reference to FSAR Tier 2, Sections 9.4.1, “Main Control Room Air Conditioning System,” and 9.5.1, “Fire Protection System,” for the design evaluation of the CRACS for this purpose.

Area-wide smoke detection is provided. During normal operation and for a radiological event, the MCR is maintained at positive pressure with respect to the outside and adjacent areas.

FSAR Tier 2, Revision 2, Section 9.4.1.1 states that, in the event of external fire or smoke, the outside inlet isolation damper (at the inlet location where smoke is detected) is closed manually from the control room. The CREF (iodine filtration) trains are placed in the filtered alignment mode manually from the control room.

Closure of the outside air damper at the site of the toxic gas event continues to allow the CRE area to meet environmental habitability requirements. Therefore, the staff finds the February 27, 2009, response to RAI 135, Question 09.04.05-1 (#3 Item b) and the FSAR revision acceptable.

Based on the above discussion, the staff finds that the U.S. EPR design conforms to the guidance of RG 1.196 with regard to the plant’s ability to be safely shut down or manage the infiltration of smoke into the CRE.

10 CFR 50.63 – Station Blackout

In the event of SBO, the SBO diesel generators (SBODG) provide alternate alternating current (ac) to Division 1 and 4 electrical components, which power two trains of CRACS to maintain habitability in the MCR.

The staff notes that FSAR Tier 2, Figures 9.4.1-1 through 9.4.1-3 and FSAR Tier 1, Table 2.6.1-1 shows Air Intake isolation dampers 30SAB01AA003 and 30SAB04AA003 are normally powered from Divisions 2 and 3, respectively. In the event of an SBO, only Divisions 1 and 4 receive power from the SBODG, powering Recirculation Trains 1 and 4. This isolates both trains of the Air Intake system and requires CRACS to operate in the recirculation mode until site power is restored or the CRACS is manually aligned to restore fresh air makeup.

FSAR Tier 2, Section 16, Technical Specification B 3.7.10, states that each of the four recirculation trains is a 75 percent capacity train with iodine filtration train capacity at 100 percent. In RAI 135, Question 09.04.05-1 (#2 Item 3), the staff requested that the applicant clarify the capacity of each of the recirculation trains.

In a February 27, 2009, response to RAI 135, Question 09.04.05-1 (#2 Item 3), the applicant clarified that during normal and emergency operation, each CRACS cooling unit provides 50 percent of the cooling for the rooms within the CRE, but each CRACS air handling unit is capable of cooling up to 75 percent of the normal and emergency cooling load. The total cooling capacity of each CRACS air handling unit has been increased from 50 percent to 75 percent to allow a single CRACS air handling unit to cool the CRE rooms during an SBO event in conjunction with a failure of one of the recirculation trains that is backed up by alternate AC power provided by the Station Blackout Diesel Generators. The applicant revised the description in the “Air Conditioning and Recirculation Air Handling Subsystem” paragraph in FSAR Tier 2, Section 9.4.1.2.1, “General Description - Recirculation Air Handling Subsystems,” paragraph for clarity. The staff has confirmed that these FSAR revisions were incorporated into FSAR Revision 2 and finds them acceptable because they clarify the capacity of each of the CRACS recirculation trains. Based on the above, the applicant‘s response, and the FSAR revision, the staff considers RAI 135, Question 09.04.05-1 (#2 Item 3) resolved.

As stated in the “Air Conditioning and Recirculation Air Handling Subsystem” paragraph in FSAR Tier 2, Section 9.4.1.2.1, “General Description,” during an SBO event, a single CRACS air handling unit will prevent the CRE room temperature from exceeding 40 °C (104 °F) (FSAR Tier 2, Section 9.4.1.2.1, “Recirculation Air Handling Subsystem”). If the two CRACS air handling unit trains that are backed up by alternate ac power are available, normal design temperatures are maintained.

In FSAR Tier 2, Section 8.4.2.6.2, the applicant states the capability for withstanding or coping with a station blackout is based on conforming to the guidance of RG 1.155, Regulatory Position C.3.2.4, The staff finds the design of the CRACS complies with the requirements of 10 CFR 50.63 regarding the capability for responding to an SBO, specifically maintaining acceptable environmental conditions to support operator access/egress and equipment functionality during the SBO and recovery period because the Recirculation Air Handling Subsystem is consistent with the guidance of RG 1.155, Regulatory Position C.3.2.4 (FSAR Tier 2, Section 8.4.2.6.2. “RG 1.155 C.3.2 – Evaluation of Plant-Specific Station Blackout Capability (Station Blackout Coping Capability)”) and remains operational. Therefore the CRE room temperature would be expected to be maintained, and would not challenge equipment operability or operator performance. Any elevated CRE temperature would be sustained for a relatively short coping period before the expected restoration of safety-related ac power sources.

Based on the above discussions, the staff finds that all portions of RAI 135, Question 09.04.05-1 (#3) are resolved. The staff finds that the CRACS, in conjunction with the CREF, provides adequate protection to permit access to and occupancy of the control room under accident conditions. In addition, the CRACS, in conjunction with the CREF, provides acceptable environmental conditions (such as temperature, humidity, and air quality) for personnel and equipment to function. Accordingly, the staff finds that the CBVS complies with the requirements of GDC 19 and 10 CFR 50.63.

GDC 60, Atmosphere Cleanup Systems

GDC 60, “Control of Releases of Radioactive Materials to the Environment,” requires that the nuclear power unit design include means to control suitably the release of radioactive materials in gaseous and liquid effluents and to handle radioactive solid wastes produced during normal reactor operation, including anticipated operational occurrences.

RG 1.140 is not applicable to the CRACS, since the system does not provide any normal atmospheric cleanup function.

In FSAR Tier 2, Table 1.9-2, “U.S. EPR Conformance with Regulatory Guides,” the applicant states that the CRACS controls the release of radioactive materials by meeting the guidance of RG 1.52.

Section 6.5.1 of this report documents the staff review of the CREF filtration system against RG 1.52. As stated in this section, the staff finds that the CREF conforms to the acceptance criteria of SRP Section 6.5.1 for ESF filter systems and conforms to the guidance of RG 1.52.

During normal operation, both iodine filtration trains are secured and fully bypassed with the motorized inlet dampers in the auto-closed position. If high radiation is detected at the air intake, the fresh air supply is automatically redirected through the iodine filtration trains, and the trains are placed in operation. Additionally, recirculation flow is directed through the iodine filtration train. As stated in FSAR Tier 2, Chapter 16, Section B 3.7.10, when one iodine filtration train operates, the outside fresh airflow rate is 28.3 m^3/min (1,000 cfm), and the CRE recirculation airflow rate is 85 m^3/min (3,000 cfm), a total flow rate of 113.3 m^3/min (4,000 cfm). The operation of CRACS creates an overpressure of 0.03 kPa gage (0.125 in. water gauge) as a minimum inside the CRE area to limit unfiltered incoming air leakage.

Therefore, because the CRACS is designed to conform to the guidance of RG 1.52, including Regulatory Position C.3, the staff finds the design of the safety-related portions of the CRACS complies with GDC 60 regarding provisions to suitably control the release of gaseous and liquid radioactive effluents to the environment.

Technical Specifications & Surveillance

Technical specification and surveillance requirements for CRACS (FSAR Tier 2, Chapter 16) were reviewed and are discussed as follows.

FSAR Tier 2, Chapter 16, Technical Specification B 3.7.11, “Applicable Safety Analyses,” states, “During emergency operation, one train is assumed to be out for maintenance and a second train is assumed lost to single failure. The two OPERABLE CRACS trains maintain the MCR temperature between 20 °C to 25.6 °C (68 °F to 78 °F)..” There are two CRACS trains in Safeguard Building Division 2, and another two CRACS trains in Safeguard Building Division 3. Based on a review of the FSAR, the staff notes that if both CRACS trains in the same Safeguard Building division fail, there is no supply air flow to half the CRE areas. The air flows in and out of each control room area are prebalanced, thereby minimizing any mixing between areas. In RAI 135, Question 09.04.05-1 (#4), the staff requested that the applicant address in the Technical Specifications the situation when two CRACS trains in the same Safeguard Building division are inoperable.

In a February 27, 2009, response to RAI 135, Question 09.04.05-1 (#4), the applicant stated that it had modified the system design such that the supply plenum located in Safeguard Building 2 is interconnected and opens to the supply plenum located in Safeguard Building 3. Likewise, the recirculation plenum located in Safeguard Building 2 is interconnected and open to the recirculation plenum located in Safeguard Building 3. This modification allows any two of the four CRACS air handling units to supply all the CRE rooms. The applicant also proposed a revision to FSAR Tier 1, Figures 2.6.1-2, and 2.6.1-3 and FSAR Tier 2, Figures 9.4.1-2 and 9.4.1-3 to incorporate the system modifications. The applicant also revised FSAR Tier 2, Chapter 16, Section 3.7.11 and Bases Section B3.7.11 to address both a single CRACS train and two CRACS trains inoperable separately. The staff has confirmed that these FSAR revisions were incorporated into FSAR Revision 2 and finds them acceptable because they ensure that all CRE areas would receive air conditioning and recirculation air flow in the event of loss of two CRACS trains in the same Safeguard Building division. Based on the above, the applicant's response, and the FSAR revision, the staff considers RAI 135, Question 09.04.05-1 (#4) resolved.

CRACS is addressed in FSAR Tier 2, Chapter 16, Technical Specifications 3.7.11 and B 3.7.11. The staff reviewed these FSAR sections and finds them acceptable, because they require the CRACS to be operable during all operating modes. The contain Limiting Conditions on Operation for the CRACS that conform to the guidance for standard technical specifications for Westinghouse plants. NUREG-1431 for the Control Room Emergency Air Temperature Control System (CREATCS), which performs the equivalent function as the U.S. EPR CRACS system. Therefore, the staff finds the CRACS technical specifications and bases acceptable because the design bases were correctly translated into the specifications. CRACS must be operable in Modes 1, 2, 3, 4, 5, 6 and when handling irradiated fuel.

ITAAC

The staff reviewed the proposed ITAAC for the CRACS and its associated safety-related features. The applicant proposed ITAAC requirements in FSAR Tier 1, Table 2.6.1-3, and FSAR Tier 2, Section 14.3 were reviewed. The staff finds that sufficient information has been provided to comply with the requirements of SRP Section 14.3 and SRP 14.3.7.

The staff reviewed the criteria that assure the performance requirements of the Main Control Room Air Conditioning System will be met for all modes of operation including normal, abnormal, SBO, and toxic gas modes. The staff has reviewed the above FSAR Tier 2 temperature limits for normal operation and Technical Specification SR 3.7.11.1, which verifies that each CRACS train has the capability to remove the design heat load. In RAI 277, Question 09.04.01-1, the staff requested that the applicant include an ITAAC that verifies that the CRACS maintains ambient temperature conditions in the Control Room Envelope. In this RAI, the staff also requested the applicant provide a description in the FSAR on how the capability of the system to remove the design heat load will be verified. In this RAI the staff also requested that the applicant clarify and justify the safety classification of the CRACS space heaters, and provide justification that failure of these components would not challenge the operability of safety-related equipment located nearby. **RAI 277, Question 09.04.01–1 is being tracked as an open item.**

Since the applicant has included an ITAAC to demonstrate the heat removal capacity of the CRACS through testing and analysis using as-built heat loads and cooling capacity, the staff has concluded that the CRACS in a plant that incorporates the design certification will be built and will operate in accordance with NRC regulations. Therefore, the staff finds the proposed ITAAC acceptable.

Initial Plant Test Program

Initial plant testing requirements given for the CRACS in FSAR Tier 2, Section 14.2, "Initial Plant Test Program," are Main Control Room Air Conditioning System (Test No. 082). No additional preoperational testing is required. The staff finds these tests an acceptable means to verify that the system will perform as stated in FSAR Tier 2, Section 9.4.1.

9.4.1.5 *Combined License Information Items*

The following is a list of item numbers and descriptions from Table 1.8-2 of the FSAR.

Table 9.4.1-1 U.S. EPR Combined License Information Items

Item No.	Description	FSAR Tier 2 Section
6.4-1 6.4-2 6.4-3 6.4-4	There are no items in FSAR Tier 2, Table 1.8-2 related to CRACS, However, COL Information Item 6.4-1 requires a COL applicant that references the U.S. EPR design certification will identify the type(s) of Seismic Category I Class IE toxic gas sensors (i.e., the toxic chemical(s) of concern) necessary for control room operator protection., COL Information Item 6.4.2 requires a COL applicant that references the U.S. EPR design certification will provide written emergency planning and procedures in the event of a radiological or a hazardous chemical release within or near the plant, and will provide training of control room personnel. COL Information Item 6.4-3 requires COL applicants that reference the U.S. EPR certified design to evaluate the results of the toxic chemical accidents from FSAR Tier 2, Section 2.2.3 and address their impact on control room habitability in accordance with RG 1.78. COL Information Item 6.4-4 requires COL applicants that reference the U.S. EPR certified design to confirm that the radiation exposure of main control room occupants resulting from a design basis accident at a nearby unit on a multi unit site is bounded by the radiation exposure from the postulated design basis accidents analyzed for the U.S. EPR; or confirm that the limits of GDC 19 are met.	6.4.4

9.4.1.6 *Conclusions*

The staff reviewed information presented in the FSAR and in the applicant's responses to RAIs on the design and operation of the CRACS. The staff concluded that the system can provide a controlled environment for the comfort and safety of control room personnel and can perform its safety functions under post-accident conditions including a postulated single active failure.

The staff concludes that the design of the CRACS presented in FSAR Tier 1, Section 2.6.1 and FSAR Tier 2, Revision 2, Section 9.4.1, pending resolution of open items, complies with the requirements of GDC 2, GDC 4, GDC 19, GDC 60, and 10 CFR 50.63. Since the U.S. EPR design is a single unit, GDC 5 is not applicable. Conformance to the guidelines of RG 1.78 is addressed by a COL information item. The ITAAC and Technical Specification requirements will ensure that the CRACS and the CREF can be properly inspected, tested, and operated in accordance with the design basis as described in the FSAR and, therefore, the CRACS design complies with 10 CFR 52.47(b) (1).

9.4.2 Fuel Building Ventilation System

The fuel building ventilation system (FBVS) maintains ventilation, permits personnel access, and controls airborne radioactivity in the fuel pool equipment areas during normal operation and anticipated operational occurrences and following postulated fuel handling accidents.

9.4.2.1 *Introduction*

The FBVS is designed to limit spread of the airborne contaminants and, during normal operation, maintains a negative pressure in the Fuel Building with respect to the outside environment. Rooms identified as having possible radioactive contamination are designed to be at a negative pressure relative to the adjacent rooms to make sure air flows from areas of low radioactivity to areas of potentially higher radioactivity. The FBVS receives the conditioned air supply from the nuclear auxiliary building ventilation system (NABVS). The FBVS exhaust is processed through the filtration divisions of the NABVS prior to discharge through the plant stack, unless there is an isolation signal, in which case the FB atmosphere is then processed through iodine filtration divisions of the safeguard building controlled area ventilation system (SBVS).

9.4.2.2 *Summary of Application*

FSAR Tier 1: FSAR Tier 1, Section 2.6.4, “Fuel Building Ventilation System,” provides the functional arrangement of the FBVS equipment as shown in FSAR Tier 1, Figure 2.6.4-1, “Fuel Building Ventilation System Functional Arrangement.” This section identifies the safety-related functions of the FBVS, as well as the non-safety-related functions. FSAR Tier 1, Table 2.6.4-1, “Fuel Building Ventilation System Equipment Mechanical Design,” lists the FBVS equipment and identifies equipment as Seismic Category I and designed to ASME AG-1 Code. FBVS equipment tag numbers, location, Institute of Electrical and Electronics Engineers (IEEE) Class, Environmental Qualification (EQ) Classification, failure positions, displays, and controls are as shown in FSAR Tier 1, Table 2.6.4-2, “Fuel Building Ventilation System Equipment I&C and Electrical Design.” The components designated as Class 1E in FSAR Tier 1, Table 2.6.4-2 are powered from the IEEE Class 1E division as given in FSAR Tier 1, Table 2.6.4-2 in a normal or alternate feed condition

FSAR Tier 2: The applicant has provided a FSAR Tier 2 system description in Section 9.4.2, summarized here, in part, as follows:

FSAR Tier 2, Figure 9.4.2-1, “Fuel Building Ventilation System,” is the FBVS flow diagram. Component descriptions for the FBVS ductwork and accessories, electric heaters, fan heaters, recirculation cooling coils, and dampers are discussed in FSAR Tier 2, Section 9.4.2.2.2, “Component Description.” Within this section, the FSAR describes operation of the FBVS under normal and abnormal conditions. During normal plant operation, fresh conditioned air is supplied to the FB rooms by the FBVS supply duct network. The supply air to the FB is provided by the NABVS. The room air conditioning is provided by the supply and exhaust air flows based on the minimum necessary air renewal rate, equipment heat load, and heat balance between the rooms. The air is heated or cooled to maintain the necessary ambient conditions of the rooms. Isolation dampers are open to provide ventilation of the FB. These isolation dampers also can be controlled by the NABVS. System fire dampers are also in the open position.

Abnormal operation includes failure of supply and exhaust air, failure of heaters and recirculation cooling coils, failure of isolation dampers, fuel handling accident in the Fuel Building, fuel handling accident in the Containment Building, loss-of-coolant accident, loss of offsite power, and station blackout.

ITAAC: Inspections, tests, analyses, and acceptance criteria for containment isolation equipment are shown in FSAR Tier 1, Table 2.6.4-3, "Fuel Building Ventilation System ITAAC."

Technical Specifications: There are no Technical Specifications associated with the fuel building ventilation system.

Initial Plant Test Program: Initial plant testing of the FBVS is described in FSAR Tier 2, Section 14.2.12.8.9, "Fuel Building Ventilation System (Test No. 081)."

9.4.2.3 *Regulatory Basis*

The relevant requirements of NRC regulations for this area of review, and the associated acceptance criteria, are given in NUREG-0800, Section 9.4.2, "Spent Fuel Pool Area Ventilation System," and are summarized below. Review interfaces with other SRP sections also can be found in NUREG-0800, Section 9.4.2.

1. GDC 2, as it relates to the requirement that a system be capable of withstanding the effects of earthquakes.

2. GDC 5, as it relates to the requirement that sharing a SSC between multiple units will not significantly impair the SSC's ability to perform their safety function in the event one unit experiences an accident condition.

3. GDC 60, as it relates to the requirement that a system be capable of controlling the release of gaseous radioactive effluents to the environment.

4. GDC 61, as it relates to the requirement that a system be capable of providing 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.

5. 10 CFR 52.47(b)(1), as it relates to the requirement that a design certification application contain the proposed ITAAC that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests and analyses are performed and the acceptance criteria are met, a plant that incorporates the design certification and is constructed will operate in conformance with the design certification and in compliance with the provisions of the Atomic Energy Act of 1954 and NRC regulations.

Acceptance criteria adequate to meet the above requirements include:

1. For GDC 2, the FBVS should meet the guidance of RG 1.29, "Seismic Design Classification," Revision 4, March 2007, Regulatory Position C.1, for safety-related portions and Regulatory Position C.2 for non-safety-related portions.

2. For GDC 5, acceptance is based on the determination that sharing of FBVS structures systems and components in multiple-unit plants does not significantly impair their ability

to perform their safety functions, including, in the event of an accident in one unit, an orderly shutdown and cooldown of the remaining unit(s).

3. For GDC 60, FBVS should meet the guidance of RG 1.52, “Design, Testing, and Inspection Criteria for Air Filtration and Adsorption Units of Post-Accident Engineered-Safety-Feature Atmosphere Cleanup Systems in Light-Water-Cooled Nuclear Power Plants,” Revision 3, June 2001, Regulatory Position C3, and RG 1.140, “Design, Inspection, and Testing Criteria for Air Filtration and Adsorption Units of Normal Atmosphere Cleanup Systems in Light-Water-Cooled Nuclear Power Plants,” Revision 2, June 2001, Regulatory Positions C.2 and C.3.

4. For GDC 61, FBVS should meet the guidance of RG 1.13 as related to the design of the ventilation system for the spent fuel storage facility, Regulatory Position C.4.

5. For 10 CFR 52.47(b) (1), FBVS should meet the guidance of RG 1.206, Section C.II.1, “Inspections, Tests, Analyses, and Acceptance Criteria,” and that contained in SRP Sections 14.3, “Inspections, Tests, Analyses, and Acceptance Criteria,” and 14.3.7, “Plant Systems-Inspections, Tests Analyses and Acceptance Criteria.”

9.4.2.4 *Technical Evaluation*

The FBVS is divided into two subsystems referred to as Cell 4 and Cell 5. The cells separate the ventilation systems serving the redundant systems in the Fuel Building, and each cell serves approximately half of the building.

The FBVS provides the following safety-related functions:

- Isolation of the supply and exhaust airflow of the fuel handling hall
- Isolation of the supply and exhaust airflow of the hall in front of equipment hatch
- Isolation of the supply and exhaust airflow to the room in front of the emergency air lock
- Isolation of the FB from NABVS supply and exhaust on receipt of containment isolation signal or high radiation signal in the Reactor Building. The FB atmosphere is then processed through iodine filtration divisions of the SBVS.
- Heating of the rooms which have safety-related systems, structures, or components containing borated fluid and the rooms surrounding the extra borating system tanks to maintain minimum ambient room temperatures
- Cooling of rooms which have the extra borating system pumps and the fuel pool cooling system pumps to maintain ambient conditions

The FBVS provides the following non-safety-related functions:

- Maintains the room ambient conditions for operation of equipment and to allow personnel access during normal operation
- Reduces spread of contamination from the contaminated rooms to less contaminated rooms during normal operation

- Reduces concentration of aerosols and radioactive gases from the room air
- Maintains a negative pressure within the Fuel Building with respect to outside atmosphere

The staff reviewed the FSAR and supporting Tier 2 information in accordance with SRP Section 9.4.2, Section III. The results and conclusions reached are as follows:

GDC 2, Natural Phenomena

FSAR Tier 2, Section 9.4.2.1, "Design Bases," identifies the safety-related components of the FBVS. As shown in FSAR Tier 1, Table 2.6.4-1, the FBVS equipment given is designed as Seismic Category I, conforming to the guidance in RG 1.29. During the review, the staff raised questions relative to possible drawing discrepancies. In RAI 135, Question 09.04.05-1 (#5), the staff requested that the applicant justify or correct these discrepancies.

In a February 27, 2009, response to RAI 135, Question 09.04.05-1 (#5), the applicant stated that they would clarify the safety and quality group classification and the seismic category of various components of the FBVS including the recirculating cooling units in the fuel pool cooling system and extra boarating system pump rooms. The applicant stated that FSAR Tier 1, Table 2.6.4-1 will be revised to include moisture separators for the recirculating cooling units in the fuel pool cooling system pump rooms. The applicant also stated that the water supply to the recirculation cooling units in the fuel pool pump rooms will be changed from component cooling water to safety chilled water.

The applicant provided proposed revisions to the FSAR to correct the discrepancies noted above. The staff has confirmed that these FSAR revisions were incorporated into FSAR Revision 2 and finds them acceptable because they clarify the safety classification and quality group classification of FBVS components in Tier 1 and Tier 2. Based on applicant‘s response, and the FSAR revision, the staff considers RAI 135, Question 09.04.05-1 (#5) resolved

The staff reviewed the FBVS design using guidance in NUREG-0800, Section 9.4.2 Section III. The staff finds that the ambient temperature limits for the areas serviced are given in FSAR Tier 2, Section 9.4.2.1 and the piping and instrumentation diagrams show FBVS equipment used for normal operation.

In RAI 277, Question 09.04.02-1, the staff requested that the applicant clarify the safety classification of the FBVS heaters. **RAI 277, Question 09.04.02-1 is being tracked as an open item**.

In FSAR Tier 2, Section 9.4.2.1 the applicant states that the FBVS components are located inside the FB structure, which is designed to withstand the effects of natural phenomena, such as earthquakes, tornados, hurricanes, and external missiles. Based on review of FB design as described in FSAR Tier 2, Section 3.8.4.1, the staff finds that the FB is a Seismic Category 1 structure. The staff review of Seismic Category I structures is described further in Chapter 3 of this report.

The staff reviewed the safety and quality group classification of structures, systems and components that are located in areas serviced by the FBVS as presented in FSAR Tier 2, Table 3.2.2.1, "Classification Summary." The staff concluded that for those areas containing safety-related equipment, the FBVS is classified Seismic Category 1 and safety-related, thus designed to function to maintain suitable environmental conditions for the serviced equipment.

Since FBVS components are located in a Seismic Category I structure, and based on the safety and quality group classifications of FBVS components that are required to function in order to perform the FBVS safety–related functions as they are described in FSAR Tier 2, Section 9.4.2.3, the staff finds that the applicant has complied with the requirements of GDC 2 with respect to the system being capable of withstanding the effects of earthquakes by conforming to the guidelines of RG 1.29, Regulatory Position C.1 for safety-related portions and Regulatory Position C.2 for non-safety-related portions.

GDC 5, Shared Systems and Components Important to Safety

The staff reviewed the design of the FBVS to ensure that the applicant has met the relevant requirements of GDC 5.

GDC 5 governs the sharing of structures, systems, and components important to safety among nuclear power plant units in order to ensure such sharing will not significantly impair their ability to perform their safety functions. The U.S. EPR design is a single-unit station, and the requirements of GDC 5 are not applicable to the single-unit design.

GDC 60, Atmosphere Cleanup Systems

GDC 60, control of releases of radioactive materials to the environment, requires that the nuclear power unit design include means to control suitably the release of radioactive materials in gaseous and liquid effluents and to handle radioactive solid wastes produced during normal reactor operation, including anticipated operational occurrences.

FSAR Tier 2, Section 9.4.2.1, states that the release of radioactive material to the environment is controlled by meeting the guidance of RG 1.140, Revision 2, Regulatory Positions C.2 and C.3. The applicant describes the control of radioactive contamination in FSAR Tier 2, Sections 9.4.2.1; 9.4.2.2.1, "General Description," and 9.4.2.2.3, "System Operation." For rooms having the potential for radioactive contamination, the FBVS maintains a negative pressure relative to adjacent rooms to ensure air flows from areas of low radioactivity to areas of potentially higher radioactivity.

The staff finds that RG 1.140 is applicable to the FBVS, since portions of the FBVS in conjunction with the safety-related and non-safety-related portions of the NABVS perform normal atmosphere cleanup functions for the FB in the U.S. EPR design and non-safety-related portions of those systems are not required to function to mitigate the consequences of a design basis accident.

The staff reviewed compliance with RG 1.140, Regulatory Positions C.2 and C.3 as explained below.

FSAR Tier 2, Section 9.4.2.2.3 states that in the event of a fuel handling accident in the FB, the air exhaust and supply of the space above the fuel pools are isolated by closing the isolation dampers serving this room. This occurs automatically by the sampling activity monitoring system signal. Alternatively, this isolation also can be performed via local push buttons located in the fuel pool room. To prevent spread of airborne contamination, the safety-related ESF iodine filtration divisions of the SBVS are used to process the exhaust air and to maintain the required negative pressure in the FB fuel pool hall, as discussed in FSAR Tier 2, Section 9.4.5. The remainder of the FB is ventilated by the NABVS. In the event of a fuel handling accident in the Containment Building, to preclude uncontrolled migration of contamination, the FB areas in front of the emergency airlock and in front of the equipment hatch are isolated by closing the air exhaust and supply dampers dedicated to these areas.

From the aforementioned information, the staff finds that the U.S. EPR FBVS design complies with NUREG-0800, Section 9.2.4 guidance with respect to the capability to ensure suitable controls on the release of radioactive materials in gaseous effluents during normal operation and anticipated operational occurrences.

The air supply to and exhaust from each room in the FB is provided by a network of supply and exhaust ducts which are connected to the NAVBS. As stated in FSAR Tier 2, Section 9.4.3, "Nuclear Auxiliary Building Ventilation System," during normal operation, if radioactive contamination is detected in the Fuel Building, the NAVBS will divert its exhaust air through an activated charcoal filtration bed prior to discharge through the plant stack. The normal atmosphere cleanup system filtration equipment is located in the NABVS, and it is discussed in FSAR Tier 2, Section 9.4.3. Therefore, the guidance for the normal atmosphere cleanup system outlined in RG 1.140, Revision 2, Regulatory Positions C.2 and C.3 are reviewed in the NAVBS section of this report.

The staff reviewed the balance of the FBVS, which includes dampers, ducting and instrumentation not associated with the filtration equipment against RG 1.140, Regulatory Positions C.2 and C3.

The staff noted that FSAR Tier 2, Section 9.4.2.6, "References," gives the 2003 version of ASME AG-1 including the AG-1a, 2004 Addenda. The staff also noted that ASME AG-1-1997 is the most recent version of this code endorsed by the NRC. Therefore, in RAI 312, Question 09.04.02-3 and RAI 462, Question 06.05.01-5, the staff requested that the applicant either reference ASME AG-1-1997 or justify its use of ASME AG-1-2003.

In RAI 462, Question 06.05.01-5, the staff requested that the applicant to clarify the discrepancy between the RG 1.140 and RG 1.52 endorsed versions of ASME AG-1 and ASME N509, "Nuclear Power Plant Air-Cleaning Units and Components," and the version of those documents referenced in the FSAR. RAI 462, Question 06.05.01-5 is being tracked as an open item in Chapter 6 of this report.

The staff reviewed the FBVS component descriptions as described in FSAR Tier 2, Section 9.4.2.2.2 and finds that they comply with RG 1.140, Regulatory Position C.2 and C.3, because they will be designed, inspected and tested in accordance with ASME AG-1.

In RAI 277, Question 09.04.02-2, the staff requested that the applicant clarify the instrumentation requirements for the FBVS in the FSAR as it relates to RG 1.140, Regulatory Position C.3.3, which recommends that normal atmosphere cleanup systems be instrumented to monitor and alarm pertinent pressure drops and flow rates in accordance with the recommendations of ERDA 76-21, Section 5.6 and ASME N509-1989, Section 4.9.

In an October 16, 2009, response to RAI 277, Question 09.04.02-2, the applicant stated that the conditioned air supply to the FBVS is provided by the NABVS. The exhaust from the FBVS is processed by the NABVS through a filtration train, and the exhaust air is directed to the plant stack. Although RG 1.140 is not directly applicable to the FBVS exhaust air cleanup, the intent of RG 1.140 is met since the exhaust air is processed through the NABVS filtration units. The applicant clarified FSAR Tier 2, Section 9.4.2.5, "Instrumentation Requirements," to delete references to instrumentation related to filtration components. The staff reviewed the October 16, 2009, response RAI 277, Question 09.04.02-2, and finds it acceptable because the

FSAR revision makes it clear that the normal atmosphere filtration components are located in the NABVS. Therefore, the staff considers RAI 277, Question 09.04.02-2 resolved.

The staff reviewed FSAR Tier 2, Section 9.4.2.5, "Instrumentation Requirements," and the list of the FBVS instrumentation with displays that are retrievable in the MCR listed in FSAR Tier 1, Table 2.6.4-1 and finds that they provide adequate information to control room operators to ensure that system functions will be maintained as required. ASME AG-1 is listed as the applicable code for this instrumentation. The staff finds that the applicant has complied with the applicable ASME standard, and is therefore acceptable.

Accordingly, and based on the above discussion the staff finds that the U.S. EPR FBVS design conforms to the applicable guidance of NUREG-0800, Section 9.4.2 and RG 1.1.140, Regulatory Positions C.2 and C.3 and, therefore, complies with the requirements of GDC 60.

GDC 61, Fuel Storage Facility Atmosphere Containment and Filtering Systems

The staff reviewed the FBVS system as it applies to RG 1.13, Regulatory Position C.4, which states that a controlled-leakage building should enclose the fuel to limit the potential release of radioactive iodine and other radioactive materials. If necessary to limit offsite dose consequences from a fuel handling accident or spent fuel pool boiling, the building should include an engineered safety feature filtration system that meets the guidelines outlined in RG 1.52.

The staff finds that component failure and redundancy are described under Abnormal Operating Conditions in FSAR Tier 2, Section 9.4.2.2.3. The safety-related portion of the FBVS is designed to function assuming a loss of any component or loss of offsite power. A review of the drawings and descriptions verified that two automatically-operated isolation dampers in series separate nonessential from essential portions and components. The review also supports that the system has been adequately designed to limit airborne activity during normal operation or in the event of a fuel handling accident. The staff notes that there was no mention of the potential impact on system components in the event of spent fuel pool boiling. Therefore, in RAI 135, Question 09.04.05-1 (#6), the staff requested that the applicant justify the potential impact of the moisture in the system from pool boiling.

In a February 27, 2009, response to RAI 135, Question 09.04.05-1 (#6), the applicant stated that spent fuel pool boiling need not be considered in the design of U.S. EPR fuel building ventilation system based on the following justification:

- The U.S. EPR fuel pool cooling system (FPCS) is designated as safety-related and Seismic Category I. The FPCS is also capable of removing the maximum spent fuel pool heat load following a single failure. Therefore, per SRP 9.1.3, "Spent Fuel Pool Cooling and Cleanup System," Revision 2, March 2007, the FBVS need not be designed for spent fuel pool (SFP) boiling conditions.

The applicant also replied that the engineered safety feature (ESF) filters in the safeguard building ventilation system that support FBVS do not have to be designed for bulk pool boiling. The applicant states that the February 27, 2009, response to RAI 135, Question 09.04.05-1 (#6) addresses moisture removal for the SBVS during other operational events.

The staff reviewed the information provided by the applicant and finds it acceptable because the ESF filter trains that service the FB have design provisions to remove moisture and control humidity to protect the charcoal filters. Therefore, the staff considers RAI 135, Question 09.04.05-1 (#6) resolved.

The staff finds that the FBVS design complies with GDC 61 by conforming to the guidance in RG 1.13, Regulatory Position C.4 with respect to ensuring isolation of the normal ventilation system and actuating the emergency filtration and adsorption systems in the event of a fuel handling accident in the Fuel Building, because the U.S. EPR design utilizes a controlled-leakage building which encloses the fuel to limit the potential release of radioactive iodine and other radioactive materials. By use of the SBVS iodine filtration trains, the staff finds that the FVBS design includes an ESF filtration system that meets the guidelines of RG 1.52. The staff review of the ESF filtration trains as they relate to RG 1.52 and GDC 60 is discussed in Section 6.5.1 of this report.

ITAAC

The staff reviewed the proposed ITAAC for the FBVS and its associated safety-related features. The applicant's proposed ITAAC requirements in FSAR Tier 1, Tables 2.6.1-4, and FSAR Tier 2, Section 14.3 were reviewed. The staff finds that sufficient information has been provided to comply with SRP Section 14.3 and SRP Section 14.3.7.

The staff finds that the FSAR Tier 1 ITAAC tables adequately address verification of the functional arrangement, physical separation, and seismic qualification of the FBVS. The staff concludes that the design, fabrication, inspection of the FBVS filter systems is in accordance with ASME AG-1 code requirements. The staff also concludes that ITAAC tables verify the minimum inventory of FBVS Alarms Displays and controls and the ITAAC verify required safety-related functions of the FBVS. Based on this review, the staff has concluded that the FBVS of a plant that incorporates the design certification will be built and will operate in accordance with NRC regulations.

Technical Specifications

There are no Technical Specifications associated with FBVS. Safety-related atmospheric cleanup functions are controlled by the SBVS technical specifications. The staff finds this complies with NUREG-0800, Section 16 and NUREG-1431, "Standard Technical Specifications (STS) for Westinghouse Plants," for the FBVS, and is therefore acceptable.

Initial Plant Test Program

Initial plant testing requirements given for the FBVS in FSAR Tier 2, Section 14.2, "Initial Plant Test Program," are Fuel Building Ventilation System (Test #081) and Ventilation Capability (Test #203) The staff finds these tests acceptable to verify that the system will perform as stated in FSAR Tier 2, Section 9.4.2.

9.4.2.5 *Combined License Information Items*

There are no COL information items in FSAR Tier 2, Table 1.8-2 related to FBVS. The staff concludes that no additional COL information items need to be included in FSAR Tier 2, Table 1.8-2 for FBVS consideration.

9.4.2.6 *Conclusions*

The fuel building ventilation system was reviewed to the acceptance criteria guidance defined in NUREG-0800, Section 9.4.2. Except for the open items related to RAI 277, Question 09.04.02-1 and RAI 462, Question 06.05.01-5, the staff concludes that the U.S. EPR FBVS complies with the requirements of GDC 2, GDC 60, and GDC 61. Since the U.S. EPR design is a single unit, GDC 5 is not applicable. The staff concludes that the ITAAC requirements will ensure that the FBVS can be properly inspected, tested, and operated in accordance with FSAR requirements and, therefore, consider that the FBVS design complies with 10 CFR 52.47(b) (1).

9.4.3 Nuclear Auxiliary Building Ventilation System (FSAR Tier 2, Section 9.4.3) and Radioactive Waste Building Ventilation System (FSAR Tier 2, Section 9.4.8)

9.4.3.1 *Introduction*

This section evaluates FSAR Tier 2, Sections 9.4.3, “Nuclear Auxiliary Building Ventilation System,” and 9.4.8, “Radioactive Waste Building Ventilation System.”

The function of the NABVS is to provide conditioned air to the NAB to maintain acceptable ambient conditions to permit personnel access, and to control the concentration of airborne radioactive material during normal operations and anticipated operational occurrences. The system also provides conditioned air to the Fuel Building, Containment Building, and the annulus area between the Containment Building and the Shield Building.

The Function of the Radioactive Waste Building Ventilation System (RWBVS) is to provide fresh conditioned air to the Radioactive Waste Building (RWB) to maintain acceptable ambient conditions and to maintain a sub-atmospheric pressure to prevent the release of airborne contaminants into the outside atmosphere during normal plant operation.

9.4.3.2 *Summary of Application*

FSAR Tier 1: As stated in FSAR Tier 1, Sections 2.6.5, “Nuclear Auxiliary Building Ventilation System,” and 2.6.10, “Radioactive Waste Building Ventilation System,” there are no FSAR Tier 1 entries for the NABVS and RWBVS.

FSAR Tier 2: The applicant has provided a system description in FSAR Tier 2, Sections 9.4.3, and 9.4.8 summarized here, in part, as follows:

Nuclear Auxiliary Building Ventilation System

In FSAR Tier 2, Sections 9.4.3.1, “Design Basis,” and 9.4.3.2, “System Description,” the applicant states that the NABVS supplies conditioned air to the NABVS air distribution supply air shafts and ductwork, the Containment Building Ventilation System, the Fuel Building Ventilation System, and the Annulus Ventilation System (AVS).

The NABVS is classified as non-safety-related and non-seismic in accordance with FSAR Tier 2, Section 3.2, “Classification of Structures, Systems, and Components.” The system is not required to operate during a design-basis accident. The NABVS performs the following important non-safety-related functions:

- Controls and maintains a negative pressure within the NAB relative to the outside environment which prevents the leakage of potentially contaminated air to the environment

- Maintains a temperature range between 10 °C – 45 °C (50 °F – 113 °F) and humidity range of 25 to 70 percent for the areas serviced

The NABVS is divided into the following three subsystems: Supply Air; NAB Air Supply; and Exhaust Air.

NABVS Supply Air Subsystem

The supply air subsystem pulls outside air through an intake structure consisting of mesh grills and louver dampers. The air passes through three filtration divisions supplying the inlet plenum. Each filtration division consists of preheater, prefilter, cooling coil, heater, silencer, humidifier, and air dampers. Four supply fans take suction from the inlet plenum and supply air to the NABVS distribution air shafts and ductwork, CBVS, FBVS, and AVS.

NABVS Nuclear Auxiliary Building Air Supply Subsystem

The nuclear auxiliary building air supply subsystem supplies conditioned air to the NAB to maintain the required ambient temperatures for equipment and personnel access. During normal operation, the NAB is also maintained at a negative pressure to prevent the possibility of contaminated air leaking into the environment. The air flow paths are monitored for radioactive contamination, so that the migration of contaminated air from areas of high radioactivity to areas of low radioactivity is limited. The subsystem also contains recirculation cooling units for conditioning areas with greater heat loads.

NABVS Exhaust Air Subsystem

The exhaust air subsystem processes exhaust air from the Fuel Building, NAB, Safeguard Building, and Containment Building full flow exhaust purge. The exhaust air from these flow paths under normal operating conditions passes through filtration divisions consisting of a prefilter and a high-efficiency particulate air filter. The flow paths open into a common plenum where four exhaust fans take suction and discharge the air through the vent stack.

In normal situations where high radioactivity is detected, the exhaust air is diverted to an iodine filtration plenum, which is then directed to one of the four redundant independent iodine filtration units for processing. Each iodine filtration unit consists of fire dampers, preheater, iodine adsorber containing activated carbon, HEPA filters, dampers, and a booster fan. The exhaust air from the booster fan is diverted to the exhaust plenum where it is discharged through the vent stack.

The NABVS also consists of two iodine filtration division units used for processing the exhaust air from the laboratory.

Radioactive Waste Ventilation System

In FSAR Tier 2, Sections 9.4.8.1, “Design Basis,” and 9.4.8.2, “System Description,” the applicant states that the RWBVS supplies conditioned air and processes and removes exhaust air from the Radioactive Waste Building. The system is designed as a once-through ventilation system with no air recirculation capability except for the evaporator, I&C, and vehicle access rooms.

The RWBVS is classified as non-safety-related and non-seismic in accordance with FSAR Tier 2, Section 3.2. Failure of the system does not affect the reactor coolant system pressure boundary or the safe-shutdown of the plant, nor is it required to mitigate the consequences of a 10 CFR Part 100 release. The RWBVS does perform the following important non-safety-related functions:

- Controls and maintains a negative pressure within the RWB relative to the outside environment which prevents the leakage of potentially contaminated air to the environment
- Maintains a temperature range between 20 °C–33 °C (68 °F–91 °F) and humidity range of 30 to 70 percent for the areas serviced
- Removes radioactivity from the exhaust air through the use of HEPA filters and iodine adsorption charcoal filtration units

RWBFS System Supply Air Subsystem

The supply air subsystem consists of two filtration divisions, which include a preheater, prefilter, filter, cooling coil, system heater, fan, and back draft damper. Two supply fans take suction on the common inlet and provide supply air to a common air duct, consisting of a humidifier and motor-driven supply damper, which maintains a negative pressure in the RWB. The back draft damper prevents short cycling supply air through the non-operating supply fan.

The RWBVS supplies fresh air under normal operation to the RWB stairwells. The SCS operates only in the event of a fire. The RWB contains two exhaust systems: system exhaust air and room exhaust air.

RWBVS System Exhaust Air Subsystem

The system exhaust air draws air from the RWB locations most likely to contain radioactivity. This would include the exhaust air and gases from activity-bearing systems, vented air from tanks, and releases from working areas and machinery. The exhaust air is monitored by the sampling activity monitoring system, which will signal control room operators, in the event high radiation is detected in the RWBVS. Downstream of the SAMS, the exhaust air is processed through two parallel filter systems consisting of a prefilter, HEPA filters, and iodine adsorption charcoal filter. The treated air is exhausted by two fans and discharged through the vent stack.

RWBVS Room Exhaust Air Subsystem

The room exhaust air subsystem serves the rooms in the RWB that are not normally expected to contain radioactivity. The room exhaust air is processed through five parallel filter systems consisting of the prefilter and HEPA filter. In the event high radioactivity is detected by the SAMS, the flow path can be directed to a filter system consisting of an iodine absorption charcoal filter and a HEPA filter for processing. The exhaust air from the RWB rooms is discharged through the vent stack.

ITAAC: FSAR Tier 2, Table 14.3-8, “ITAAC Screening Summary,” (Sheet 3 of 6) indicates that the NABVS and RWBVS do not have a FSAR Tier 1 ITAAC.

Technical Specifications: There are no Technical Specifications associated with the nuclear auxiliary building ventilation system and radioactive waste building ventilation system.

9.4.3.3 *Regulatory Basis*

The relevant requirements of the NRC regulations for this area of review and the associated acceptance criteria are given in NUREG-0800, Section 9.4.3, “Auxiliary and Radwaste Area Ventilation System,” and are summarized below. Review interfaces with other SRP sections can be found in NUREG-0800, Section 9.4.3.

1. GDC 2 indicates that a system shall be capable of withstanding the effects of earthquakes.

2. GDC 5 indicates that sharing a SSC between multiple units will not significantly impair the SSC’s ability to perform its safety function in the event one unit experiences an accident condition.

3. GDC 60 indicates that a system is capable of controlling the release of gaseous radioactive effluents to the environment.

4. 10 CFR 52.47(b)(1) requires that a design certification application contain the proposed ITAAC that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria is met, a plant that incorporates the design certification and is constructed will operate in compliance with the design certification, the provisions of the Atomic Energy Act of 1954, and NRC regulations.

Acceptance criteria adequate to meet the above requirements include:

1. For GDC 2, the NABVS and the RWBVS should meet the guidance of RG 1.29, “Seismic Design Classification,” Revision 4, March 2007, Regulatory Position C.1, for safety-related portions and Regulatory Position C.2 for non-safety-related portions.

2. For GDC 5, acceptance is based on the determination that sharing of NABVS and the RWBVS structures systems and components in multiple-unit plants does not significantly impair their ability to perform their safety functions, including, in the event of an accident in one unit, an orderly shutdown and cooldown of the remaining unit(s).

3. For GDC 60, NABVS and the RWBVS should meet the guidance of RG 1.52 “Design, Testing, and Inspection Criteria for Air Filtration and Adsorption Units of Post-Accident Engineered-Safety-Feature Atmosphere Cleanup Systems in Light-Water-Cooled Nuclear Power Plants,” Revision 3, June 2001, Regulatory Position C.3, and RG 1.140, “Design, Inspection, and Testing Criteria for Air Filtration and Adsorption Units of Normal Atmosphere Cleanup Systems in Light-Water-Cooled Nuclear Power Plants,” Revision 2, June 2001, Regulatory Positions C.2 and C.3.

4. For 10 CFR 52.47(b) (1), NABVS and the RWBVS should meet the guidance of RG 1.206, Section C.II.1, “Inspections, Tests, Analyses, and Acceptance Criteria,” and that contained in SRP Section 14.3, “Inspections, Tests, Analyses, and Acceptance Criteria” and 14.3.7, “Plant Systems-Inspections, Tests Analyses and Acceptance Criteria.”

9.4.3.4 *Technical Evaluation*

The staff reviewed the NABVS (FSAR Tier 2, Section 9.4.3) and RBVS (FSAR Tier 2, Section 9.4.8) for conformance with the requirements and acceptance criteria defined in SRP Section 9.4.3.

9.4.3.4.1 GDC 2

The guidance for GDC 2 is based on RG 1.29, Regulatory Positions C.1 for safety-related and C.2 for non-safety-related SSCs. FSAR Tier 2, Sections 9.4.3.1 and 9.4.8.1 state that the NABVS components and RWBVS components are non-safety-related and non-seismic. The staff reviewed FSAR Tier 2, Table 3.2.2-1 (Sheet 1 − 186). The staff finds that the NABVS and RWBVS components are assigned a Safety Classification as "NS" and Seismic Category as "NSC." The staff reviewed the safety classification of SSCs in the NAB and RWB serviced by these HVAC systems and finds that, with the exception of the vent stack, there are no safety-related components that are served by or would be adversely affected by failure of these HVAC systems. Therefore the staff finds that FSAR Tier 2, Chapter 3 and Chapter 9 are consistent with regard to the safety and seismic classifications for the NABVS and RWBVS. Based on these classifications, the staff finds that RG 1.29, Regulatory Position C.2 applies to either system.

The staff reviewed the postulated design-basis accident scenarios and assumptions discussed in FSAR Tier 2, Chapter 15. The staff finds that the air intakes, ducts, air conditioning units, filters, blowers, isolation dampers and exhaust fans for the NABVS and RWBVS do not perform any safety-related function and failure of such components will not adversely affect any other safety-related system or cause injury to control room personnel; therefore, the staff finds that these components conform to RG 1.29, Regulatory Position C.2.

As shown in FSAR Tier 2, Table 3.2.2-1, the vent stack structure that exhausts air from the NABVS and RWBVS is classified as a Seismic Category I structure. The vent stack performs the safety-related functions for the AVS and SBVS. Since this non-safety-related HVAC system exhausts air through the safety-related vent stack, the staff finds that this component conforms to RG 1.29 Regulatory Position C.1.

The interfaces between the NABVS and the FBVS, SBVS, CBVS, and the AVS were reviewed by the staff to ensure that if a failure were to occur in the nuclear auxiliary building ventilation system during a safe-shutdown earthquake, the interface systems would still be able to perform their safety-related functions. The staff noted that the seismic and safety classification of some FBVS components was unclear. Therefore, in RAI 461, Question 09.04.03-4, the staff requested that the applicant clarify the following:

The staff notes that FSAR Tier 2, Figure 9.4.3-3 shows the FB and vent stack as non-seismic and non-safety-related structures, which conflicts with FSAR Tier 2, Table 3.2.2.1-1 for those structures. Since the plant stack is used by safety- related ventilation systems such as the AVS, this structure should be correctly designated on this figure as safety-related and Seismic Category 1. Additionally, since the vent stack is part of the AVS, which is relied upon to establish a negative pressure in the annulus and fission product removal after a design basis accident, the Quality group for the vent stack should be Quality Group B. Therefore, in RAI 461, Question 09.04.03-4, the staff requested that the applicant do the following:

1. Clarify FSAR Tier 2, Figure 9.4.3-3 to indicate that the plant stack, which serves as the exhaust path of the FBVS, is SSC Seismic Category 1 and SSC Quality Group B., a safety-related portion of the system.

2. Clarify the Seismic and Quality Classification breaks for the vent stack as they are shown in the FSAR in the same manner for the following Systems/ P&IDs:

    a. Safeguard Building Controlled-Area Ventilation System Figure 9.4.5-2

    b. Radioactive Waste Exhaust/ Figure 9.4.8-2

    c. Reactor Building Exhaust/ Figure 9.4.7-2

    d. Annulus Accident Filtration Train Exhaust/ Figure 6.2.3-2

RAI 461, Question 09.04.03-4 is being tracked as an open item.

Except for RAI 461, Question 09.04.03-4, the staff finds that the piping and instrumentation diagrams indicate that the proper divisions between the quality and seismic classifications for the NABVS and associated interfaced systems (FSAR Tier 2, Figures 9.4.3-1, "Nuclear Auxiliary Building Supply Air Filtration and A/C Trains," to 9.4.3-5, "Nuclear Auxiliary Building Laboratory Iodine Exhaust Filtration Train"; Figure 9.4.2-1, "Fuel Building Ventilation System"; Figure 9.4.5-1, "Safeguard Building Controlled-Area Ventilation System Air Supply Subsystem"; Figure9.4.5-2, "Safeguard Building Controlled-Area Ventilation System Exhaust Air Subsystem"; Figure 9.4.7-1, "Containment Building Low Flow and Full Flow Purge Supply Subsystem"; Figure 9.4.7-2, "Containment Building Low Flow and Full Flow Purge Exhaust Subsystem" ; Figure 6.2.3-1, "AVS Normal Operation Train"; and Figure 6.2.3-2, "AVS Accident Trains"). In addition, the interface systems also provide the required isolation dampers to ensure their functional integrity is maintained during an SSE. Accordingly, based on this review, the staff finds that if the NABVS were to fail, the system will not adversely affect any other safety-related system or cause injury to control room personnel; therefore, the non-safety--related portions of the NABVS conforms to RG 1.29, Regulatory Position C.2.

The interfaces between the RWBVS the NABVS were reviewed to ensure that if a failure were to occur in the RWBVS during a safe-shutdown-earthquake, this would not prevent the interface systems from performing their safety-related functions. The staff reviewed P&ID 9.4.8-2, "Radioactive Waste Building Ventilation System Exhaust Air Station." The staff finds that the proper divisions between seismic classifications exist for the RWBVS and the NABVS Figures 9.4.3-1, "Nuclear Auxiliary Building Supply Air Filtration and A/C Trains," to 9.4.3-5, "Nuclear Auxiliary Building Laboratory Iodine Exhaust Filtration Train." Accordingly, except for the above open item, and based on this review, the staff finds that if the RWBVS were to fail, the system will not adversely affect any other safety-related system or cause injury to control room personnel; therefore, the non-safety-related portions of the RWBVS conform to RG 1.29, Regulatory Position C.2.

Therefore, except for the open item discussed above, the staff concludes that the NABVS and the RWBVS conform to the guidance in RG 1.29, Regulatory Position C.1, for safety-related portions and RG 1.29, Regulatory Position C.2 for non-safety-related portions of the systems and, therefore, NABVS and the RWBVS comply with the requirements of GDC 2.

9.4.3.4.2 GDC 5, Shared Systems and Components Important to Safety

The staff reviewed the design of the NABVS and RWBVS to ensure that the relevant requirements of GDC 5 are met.

GDC 5 governs the sharing of structures, systems, and components important to safety among nuclear power plant units in order to ensure such sharing will not significantly impair their ability to perform their safety functions. The U.S. EPR design is a single-unit station, and the requirements of GDC 5 are not applicable to the single-unit design.

9.4.3.4.3 GDC 60

GDC 60, control of releases of radioactive materials to the environment, requires that the nuclear power unit design include means to control suitably the release of radioactive materials in gaseous and liquid effluents and to handle radioactive solid wastes produced during normal reactor operation, including anticipated operational occurrences.

For the NABVS, the staff reviewed FSAR Tier 2, Section 9.4.3.1. The applicant stated that the release of radioactive material to the environment is controlled by conforming to RG 1.140, Regulatory Positions C.2 and C.3. The staff reviewed the applicant's description of the control of radioactive contamination in FSAR Tier 2, Sections 9.4.3, 9.4.3.2.1, "General Description," and 9.4.3.2.3, "System Operation." For rooms having the potential for radioactive contamination, the NABVS maintains a negative pressure relative to adjacent rooms to ensure air flows from areas of low radioactivity to areas of potentially higher radioactivity.

The staff finds that RG 1.140 is applicable to the NABVS, since the non-safety-related portions of the NABVS performs normal atmosphere cleanup functions for the NAB in the U.S. EPR design, and non-safety-related portions are not required to function to mitigate the consequences of a design basis accident.

For the RBVS, the staff reviewed FSAR Tier 2, Section 9.4.8.1. The applicant stated that the release of radioactive material to the environment is controlled by conforming to RG 1.140. The staff reviewed the applicant's description of the control of radioactive contamination in FSAR Tier 2, Sections 9.4.8, 9.4.8.2.1, "General Description," and 9.4.8.2.3, "System Operation." For rooms having the potential for radioactive contamination, the RWBVS maintains a negative pressure relative to adjacent rooms to ensure air flows from areas of low radioactivity to areas of potentially higher radioactivity.

The staff finds that RG 1.140 is applicable to the RWBVS since portions of the RWBVS in conjunction with safety-related portions of the NABVS perform normal atmosphere cleanup functions for the RWB in the U.S. EPR design. The staff finds that the non-safety-related portions of those systems are not required to function to mitigate the consequences of a design basis accident.

Therefore, the staff finds that RG 1.140, Regulatory Positions C.2 and C.3 are applicable to the RWBVS and NABVS. For both systems the safety-related portion is the vent stack. This component is reviewed by the staff against applicable criteria in RG 1.52 in the SBVS section of this report.

The staff reviewed compliance with RG 1.140 for the NABVS and RWBVS against Regulatory Positions C.2 and C.3 as discussed below.

RG 1.140, Regulatory Position C.2

The design of a normal atmosphere cleanup system should be based on the anticipated operating ranges for temperature, pressure, relative humidity, and radiation levels during normal plant operations and anticipated operational occurrences per RG 1.140, Regulatory Position C.2.1. In FSAR Tier 2, Section 9.4.3.2.2, "Component Description," the applicant states that the ductwork and accessories for the NABVS will meet the design, testing, and construction requirements identified in ASME AG-1, 2003. In FSAR Tier 2, Section 9.4.8.2.2, "Component Description," the applicant also states that the isolation dampers for the RWBVS meet the performance and testing requirements identified in ASME AG-1, 2003. The staff reviewed ASME AG-1, 2003 to determine if the operating ranges for temperature, relative humidity, pressure, and radiation levels were identified for normal plant operations and anticipated operational occurrences.

ASME AG-1 indicates that design requirements shall be specified for temperature, relative humidity, pressure, and radiation levels. ASME AG-1 does not provide the actual operating ranges. While the applicant has only provided information on the operating ranges for temperature and relative humidity associated with normal plant operation for the NABVS and RWBVS, the use of both RG 1.140 and ASME AG-1 provides assurance that the final design will consider both pressures and radiation levels for normal plant operations and anticipated operational occurrences. Therefore, the staff finds that NABVS and RWBVS conform to RG 1.140, Regulatory Position C.2.1.

If the normal atmosphere cleanup system is located in an area with high radiation during normal plant operation, then adequate shielding of components and personnel from the radiation source should be provided in accordance with RG 1.140, Regulatory Position C.2.2. The Nuclear Auxiliary Building contains two high radiation sources. These sources are identified as the coolant storage tanks and the delay beds. The coolant storage tank and delay beds are shielded by 0.76 m (2.5 ft) thick and 0.91 m (3 ft) thick concrete walls, which maintain the dose rate on the outside walls to $<1.0\times10^{-5}$ sieverts/hr (<1 mrem/hr). The Radioactive Waste Processing Building contains portions of the coolant purification system, liquid waste management system, and solid waste management system. Some of the components for these systems are classified as high radiation sources. These sources are enclosed within a shield that limits the dose rate to $<1.0\times10^{-5}$ sieverts/hr (<1 mrem/hr) per FSAR Tier 2, Section 12.3.1.4, "Nuclear Auxiliary Building." Therefore, the staff finds that the NABVS and RWBVS conform to RG 1.140, Regulatory Position C.2.2.

The operation of any normal atmosphere cleanup system should not degrade the expected operation of any ESF system that is required to operate after a design-basis accident in accordance with RG 1.140, Regulatory Position C.2.3. The staff concludes that the applicant has conformed to this guidance with regard to the NABVS or RWBVS, because these systems do not perform any ESF function per FSAR Tier 2, Sections 9.4.3.3, "Safety Evaluation," and 9.4.8.3, "Safety Evaluation."

The design of a normal atmosphere cleanup system should consider any significant contaminants such as dust, chemicals, excessive moisture, or other particulate matter that could degrade the cleanup system's operation in accordance with RG 1.140, Regulatory Position C.2.4. Materials of construction and components shall be selected and tested to limit the generation of combustibles and contaminants per ASME N509, Section 4.4, "Environmental Design Condition," and various ASME AG-1 sections. The staff noted that the applicant has committed to RG 1.140 for the NABVS and RWBVS, as stated in FSAR Tier 2, Sections 9.4.3.1

and 9.4.8.1, respectively. Therefore the staff finds that the design considers provisions for air quality including the use of intake mesh grills, louver dampers, and weather protected grills to prevent ice formation and ingress of insects and debris. System leakage rates and leak-tightness requirements are addressed in FSAR Tier 2, Sections 9.4.3.4, “Inspection and Testing Requirements,” 9.4.8.4, “Inspection and Testing Requirements,” 9.4.3.2.2, and 9.4.8.2.2 for the two systems. The staff finds that the NABVS and RWBVS ductwork and accessories are designed, tested, and constructed in accordance with ASME N509 and ASME N510, which are industry standard endorsed by RG 1.140. The staff concludes that the applicant has conformed to the guidance in RG 1.140, Regulatory Position C.2.4.

RG 1.140, Regulatory Position C.3

RG 1.140, Regulatory Position C.3.1 states that a normal atmosphere cleanup system need not be redundant nor designed to Seismic Category I classification; but at a minimum, a system should consist of the following components in the specified order:

- HEPA filters before the adsorbers
- Iodine adsorbers (impregnated activated carbon)
- Fans
- Interspersed ducts, dampers, and related instrumentation

RG 1.140 recommends that prefilters be installed upstream of the HEPA filters to increase their service life, and that HEPA filters be installed downstream of carbon adsorbers to retain carbon fines.

RG 1.140 does not call for an iodine adsorption component if the atmosphere cleanup system removes only particulate matter.

The staff reviewed the P&IDs for the NABVS and RWBVS and concluded that these two systems conform to the guidance in RG 1.140, Regulatory Position C.3.1. In addition, the staff concludes that the NABVS and RWBVS provide redundant ventilation divisions for handling operational occurrences, even though they are not specified by RG 1.140, Regulatory Position C.3.1.

To ensure reliable in-place testing, the volumetric air-flow rate of a single cleanup unit should be limited to approximately 849.51 m^3/min (30,000 CFM). If a total system air flow in excess of this rate is necessary, multiple units should be used per RG 1.140, Regulatory Position C.3.2. The applicant did not indicate whether multiple-units for the NABVS and RWBVS would be used or provide the maximum air-flow rate for each unit. Therefore, to conform to the guidance in RG 1.140, Regulatory Position C.3.2, in RAI 135, Question 09.04.05-1 (#7), the staff requested that the applicant provide data regarding the air flow rates for the NABVS and RWBVS cleanup units.

In a February 27, 2009, response to RAI 135, Question 09.04.05-1 (#7), the applicant stated that the air flow for a single cleanup filtration unit will be limited to 849.51 m^3/min (30,000 CFM). The applicant also indicated that FSAR Tier 2, Sections 9.4.3.1 and 9.4.8.1 will be revised to include a statement that a single cleanup unit will not exceed 30,000 CFM. The proposed FSAR revisions were presented in, “U.S. EPR Final Safety Analysis Report Markups,” attached to the applicant’s February 27, 2009, response to RAI 135. The staff reviewed the proposed

FSAR change and finds them acceptable. The staff has confirmed that these FSAR revisions were incorporated into FSAR Revision 2 and finds them acceptable because they establish a design limit for airflow for a single cleanup filtration unit that follows applicable guidance. Accordingly, based on applicant's response, and the FSAR revision, RAI135, Question 09.04.05-1 (#7) the staff considers this question resolved as it applies to the maximum airflow limit for each unit.

Each normal atmosphere cleanup system should be instrumented to monitor and alarm for pertinent pressure drops and flow rates, in accordance with RG 1.140, Regulatory Position C.3.3. The P&IDs for the NABVS indicate that differential pressure across filters and the vent stack air-flow rate are being monitored. The P&IDs for the RWBVS indicate that differential pressure across filters and system pressure are being monitored. In RAI 135, Question 09.04.05-1 (#7), the staff requested that the applicant provide data on the pressure and flow indication missing from the P&IDs for the NABVS and RWBVS to conform to the guidance in RG 1.140, Regulatory Position C.3.3.

In a February 27, 2009, response to RAI No. 135, Question 09.04.05-1 (#7), the applicant stated that the monitoring of differential pressure across the HEPA filters and iodine filters (adsorbers) is shown on FSAR Tier 2, Figures 9.4.3-3, "Nuclear Auxiliary Building Exhaust Filtration Trains Subsystem"; 9.4.3-4, "Nuclear Auxiliary Building Exhaust Iodine Filtration Train Subsystem"; and 9.4.8-2, "Radioactive Waste Building Ventilation System Exhaust Air Station," for the NABVS and RWBVS. The applicant identified a statement in FSAR Tier 2, Section 9.4.8.5, "Instrumentation Requirements," for the RWBVS: "all instrumentation provided with the filtration units is as required by RG 1.140." The applicant also indicates that FSAR Tier 2, Section 9.4.3.5, "Instrumentation Requirements," will be revised to include a similar statement for the NABVS; and Figures 9.4.3-3, 9.4.3-4, and 9.4.8-2 will be revised to include flow rate element sensors. The proposed FSAR revisions were presented in "U.S. EPR Final Safety Analysis Report Markups" attached to the applicant's February 27, 2009, response to RAI 135. The staff reviewed the proposed FSAR changes and finds them acceptable. The staff has confirmed that these FSAR revisions were incorporated into FSAR Revision 2 and finds them acceptable because they clarify the instrumentation requirements for the NABVS and the RWBVS follows applicable guidance. Accordingly, based on applicant's response, and the FSAR revision, RAI 135, Question 09.04.05-1 (#7), the staff considers this question resolved as it applies to instrumentation requirements for the NAVBS and RWBVS.

To maintain the radiation exposure to operating and maintenance personnel ALARA, normal atmosphere cleanup systems and components should be designed to control leakage and facilitate maintenance, inspection, and testing, per RG 1.140, Regulatory Position C.3.4. Therefore, in RAI 135, Question 09.04.05-1 (#7), the staff requested that the applicant provide this information to conform to the guidance in RG 1.140, Regulatory Position C.3.4.

In a February 27, 2009, response to RAI 135, Question 09.04.05-1 (#7), the applicant stated that RG 1.140, Regulatory Position C.3.4 is addressed in FSAR Tier 2, Sections 12.3.1.9.2, "Equipment Design Features"; and 12.3.3.3, "Protective Design Features." FSAR Tier 2, Section 12.3.1.9.2 addresses common equipment design features that help reduce personnel radiation exposure.

The section on particulate filters provides evidence that HEPA filters are used for various U.S. EPR ventilation systems to minimize dose resulting from service, testing, inspection, decontamination, and component replacement.

FSAR Tier 2, Section 12.3.3.3 provides information on the protective design features implemented in the U.S. EPR to minimize radiation exposure. These features include the following:

- Air flow direction is from low radioactivity to higher radioactivity.
- Rooms or spaces potentially contaminated are maintained at a negative pressure to minimize airborne radioactivity.
- The main control room is maintained at a positive pressure to keep out airborne radioactivity.
- Ventilated air is only recirculated in clean areas.
- Ventilation air is released to the environment after it is processed, by removing airborne radioactive iodine and particulates.
- Containment isolation valves are installed in accordance with 10 CFR Part 50, Appendix A, in order to maintain the containment integrity.
- The nuclear island drain and vent systems are connected directly to the ventilation system rather than being vented to containment spaces.
- Heating, ventilation, and air conditioning system components are located in areas with low radiation to minimize personnel exposure during maintenance, inspection, and testing.
- Maintenance of carbon filters is handled by automated equipment.
- The U.S. EPR air cleaning systems are designed, maintained, and tested in accordance with RG 1.52 for post-accident engineered safety feature atmospheric cleanup system and RG 1.140 for normal atmospheric cleanup system.

The staff reviewed FSAR Tier 2, Sections 12.3.1.9.2 and 12.3.3.3 and finds the information acceptable because the information in the FSAR clarifies the instrumentation requirements for the NABVS and the RWBVS follows applicable guidance of RG 8.8 at is applies to ALARA principles for the design of normal atmosphere cleanup systems. Accordingly, based on the applicant‘s response, and the FSAR revision, the staff considers RAI 135, Question 09.04.05-1 (#7) resolved as it applies to use of ALARA principles in the design of the NABVS and RWBVS. Therefore, the staff considers RAI 135, Question 09.04.05-1 (#7), related to RG 1.140, Regulatory Position C.3.4, resolved.

Outdoor air intake openings should be equipped with louvers, grills, screens, or similar protective devices to minimize the effects of high winds, rain, snow, ice, trash and other contaminants on the operation of the system, in accordance with the guidance in RG 1.140, Regulatory Position C.3.5. In FSAR Tier 2, Section 9.4.3.2.1, “General Description,” the applicant states that the NABVS air intake system consists of electrically heated and weather protected mesh grills and louver dampers. In FSAR Tier 2, Section 9.4.8.2.1, “General Description,” the applicant also states that the RWBVS air intake system consists of an automatically controlled damper and does not provide any additional information regarding louvers, grill, or screens. The staff finds that the NABVS conforms to RG 1.140, Regulatory Position C.3.5. Therefore, in RAI 135, Question 09.04.05-1 (#7), the staff requested that the applicant provide information on the use of louvers, grills, or screens for the RWBVS to conform to RG 1.140, Regulatory Position C.3.5.

In a February 27, 2009, response to RAI 135, Question 09.04.05-1 (#7), the applicant stated that FSAR Tier 2, Section 9.4.8.2.1 will be revised to include the following statement:

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

The proposed FSAR revisions were presented in "U.S. EPR Final Safety Analysis Report Markups," attached to the applicant's February 27, 2009, response to RAI 135. The staff reviewed the proposed FSAR change and finds it acceptable. The staff has confirmed that these FSAR revisions were incorporated into FSAR Revision 2 and finds them acceptable because they clarify the design of outdoor air intake openings for the NABVS and the RWBVS follows applicable guidance. Based on applicant's response, and the FSAR revision, RAI135, Question 09.04.05-1 (#7) the staff considers , RAI135, Question 09.04.05-1 (#7) resolved as it applies air intake design requirements for the NAVBS and RWBVS.

Normal atmosphere cleanup system housings and ductwork should be designed to exhibit, on test, a maximum total leakage rate as defined in Article SA-4500 of ASME AG-1-1997. Therefore, in RAI 135, Question 09.04.05-1 (#7), the staff requested that the applicant provide the leakage rates for the NABVS and RWBVS to demonstrate conformance with RG 1.140, Regulatory Position C.3.6.

In a February 27, 2009, response to RAI 135, Question 09.04.05-1 (#7), the applicant stated that the system leakage rates are included as part of the Inspection and Testing Requirements identified in FSAR Tier 2, Sections 9.4.3.4 and 9.4.8.4 for the NABVS and RWBVS. The system leakage initial in-place testing will be performed in accordance with ASME AG-1-2003 and ASME N510-1989, "Testing of Nuclear Air-Treatment Systems." In addition, the applicant stated that FSAR Tier 2, Sections 9.4.3.2.2 and 9.4.8.2.2 for the NABVS and RWBV indicate that the HEPA filters and adsorbers leak-tightness in-place testing are also performed in accordance with ASME N510-1989. The applicant proposed revising FSAR Tier 2, Sections 9.4.3.2.2 and 9.4.8.2.2 to include the following statement:

The proposed FSAR revisions were presented in "U.S. EPR Final Safety Analysis Report Markups" attached to the applicant's February 27, 2009, 1 response to RAI 135, Question 09.04.05-1 (#7). The staff finds the proposed FSAR changes acceptable. The staff has confirmed that these FSAR revisions were incorporated into FSAR Revision 2 and finds them acceptable because they clarify the tests and inspections that are used to verify the NABVS and the RWBVS system leakage rates.

In RAI 135, Question 09.04.05-1, Item #7, the staff requested that the applicant clarify the testing requirements for the NABVS and the RWBVS as they relate to guidance contained in RG 1.140, Regulatory Position C.3.6, which states:

> Normal atmosphere cleanup system housings and ductwork should be designed to exhibit, on test, a maximum total leakage rate as defined in Article SA-4500 of ASME AG-1-1997 (Ref. 3). Duct and housing leak tests should be performed in accordance with Section TA of ASME AG-1-1997.

In a February 27, 2009, response to RAI 135, Question 09.04.05-1, item #7, the applicant included FSAR Tier 1 and Tier 2 mark-ups. As a result of the staff's review of the response and FSAR Revision 2, in RAI 461, Question 09.04.03-5, the staff requested the following information. **RAI 461, Question 09.04.03-5 is being tracked as an open item**:

1. The staff notes that the FSAR is still unclear as to how and when duct and housing leak tests will be performed on the NABVS and RWBVS. The applicable criteria, of A,G-1 as written, only applies to the components listed in FSAR Tier 2, Section 9.4.3.2.2 for the NABVS, and FSAR Tier 2, Section 9.4.8.2.2 for the RWBVS. The system startup tests in FSAR Tier 2, Chapter 14 do not list acceptance criteria for system leakage.

   a. Revise FSAR Tier 2, Section 9.4.8.2.2, to add a "Ductwork and accessories section for the RWBVS," to clarify that the testing requirements are also applicable to RWBVS ductwork.

   b. Add total system leakage acceptance criterion to the respective startup test acceptance criteria section.

2. Item 1.b also applies to all ventilation system startup tests for those systems that are subject to either RG 1.52 or RG 1.140. These systems include the FBVS, CBVS, CRACS, SBVS, SBVSE, and the ABVS. Clarify the FSAR for these systems as it applies to item 1.b.

Therefore, the staff finds that the cited test standards conform to RG 1.140, Regulatory Position C.3.6. Accordingly, based on applicant's response, and the FSAR revision, the staff considers RAI135, Question 09.04.05-1 (#7) resolved as it applies system leakage testing requirements for the NAVBS and RWBVS.

Based on the above discussion, the staff finds that the NABVS and the RWBVS conform to RG 1.140, Regulatory Positions C.2 and C.3. Therefore, the staff finds that these systems meet the requirements of GDC 60.

9.4.3.4.4 ITAAC

The staff notes that ITAAC information is not provided for either the NABVS or the RWBVS. The staff finds this acceptable because the staff finds that both are non-safety-related, and service areas that do not contain safety-related SSCs. The staff finds that adequate inspections and tests for these systems are performed in the Initial Plant Test Program.

9.4.3.4.5 Technical Specifications

There are no Technical Specifications associated with NABVS and RWBVS. Safety-related ventilation and atmospheric cleanup functions are controlled by the SBVS and the SBVSE technical specifications. The staff finds that this complies with NUREG-0800, Section 16 and NUREG-1431, "Standard Technical Specifications (STS) for Westinghouse Plants," for the NABVS and RWBVS, and is therefore acceptable.

9.4.3.4.6 Initial Plant Test Program

Initial plant testing requirements given for the NABVS and RWBVS in FSAR Tier 2, Section 14.2, "Initial Plant Test Program," are Nuclear Auxiliary Building Ventilation System (Test #079), Radioactive Waste Building Ventilation System (Test #80) and Ventilation

Capability (Test #203) These tests were reviewed by the staff and found to be an acceptable means to verify the system will perform as stated in FSAR Tier 2, Sections 9.4.3 and 9.4.8.

9.4.3.5 *Combined License Information Items*

There are no COL information items related to this area of review. The staff concludes that there are no additional items needed for this area of review.

9.4.3.6 *Conclusions*

The staff reviewed the U.S. EPR standard design NABVS and RWBVS using the acceptance criteria guidance defined in NUREG-0800, Section 9.4.3. The staff concludes that except for RAI 461, Question 09.04.03-4 and RAI 461, Question 09.04.03-5, these systems comply with the requirements of GDC 2, and GDC 60. Since, the U.S. EPR design is a single unit, GDC 5 is not applicable. The ITAAC requirements were judged by the staff to be appropriate for these systems based on their performance requirements and, therefore, the staff concludes that the NABVS and RWBVS designs comply with 10 CFR 52.47(b) (1).

9.4.4 Turbine Island Ventilation Systems

9.4.4.1 *Introduction*

The turbine island Ventilation Systems consist of the turbine building ventilation system and the switchgear building ventilation system, turbine island (SWBVS). The function of the TBVS is to maintain adequate heating and ventilation in the Turbine Building (TB). The function of the SWBVS is to provide heating and ventilation, and cooling in the remainder of the Electrical Switchgear Building (SWGB) in order to maintain SWGB temperatures within the operating requirements for equipment operation and to establish acceptable ambient conditions for personnel to operate and maintain the equipment within the building.

9.4.4.2 *Summary of Application*

FSAR Tier 1: As stated in FSAR Tier 1, Section 2.6.15, “Turbine Island Ventilation System,” there are no FSAR Tier 1 entries for the turbine island ventilation system. FSAR Tier 1, Section 4.4, “Turbine Building,” states the COL applicant will provide the design of the Turbine Building.

FSAR Tier 2: In FSAR Tier 2, Section 9.4.4, “Turbine Island Ventilation System,” the applicant states that the function of the TBVS is to maintain adequate heating and ventilation in the Turbine Building. The function of the SWBVS is to provide heating and ventilation, in the remainder of the SWGB for normal operating modes as well as outages. The SWBVS provides conditioned air in order to maintain SWGB temperatures within the operating requirements for equipment operation and provides and acceptable environment for personnel to operate and maintain the equipment within the building. The TBVS and the SWBVS are classified as non-safety-related systems; they do not provide accident response, nor do they provide radioactive effluent control functions.

FSAR Tier 2, Table 1.8-2 requires COL applicants to provide specific design information on the TBVS (Item 9.4-1) and to provide specific design information for the switchgear building ventilation system (Item 9.4-2).

ITAAC: There are no specified ITAAC commitments or criteria associated with the turbine island ventilation system.

Technical Specifications: There are no technical specifications associated with the turbine island ventilation system.

9.4.4.3 *Regulatory Basis*

The relevant requirements of NRC regulations for this area of review, and the associated acceptance criteria, are given in NUREG-0800, Section 9.4.4, "Turbine Area Ventilation System," and are summarized below. The review of the TBVS and SWBVS includes systems contained in the TB and SWGB and their relationship, if any, to safety-related equipment areas. Review interfaces with other SRP sections also can be found in NUREG-0800, Section 9.4.4.

1. GDC 2 indicates that a system shall be capable of withstanding the effects of earthquakes.

2. GDC 5 indicates that sharing a structure, system or component between multiple units will not significantly impair the ability of the SSCs to perform its safety function in the event one unit experiences an accident condition.

3. GDC 60 indicates that a system is capable of controlling the release of gaseous radioactive effluents to the environment. GDC 60 requires provisions to be included in the nuclear power unit design to ensure suitable controls on the release of radioactive materials in gaseous effluents during normal reactor operation, including anticipated operational occurrences.

4. 10 CFR 52.47(b)(1) requires that a design certification application contain the proposed inspections, tests, analyses and acceptance criteria that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests and analyses are performed and the acceptance criteria are met, a plant that incorporates the design certification and is constructed will operate in conformance with the design certification, the provisions of the Atomic Energy Act of 1954 and NRC regulations.

Acceptance criteria adequate to meet the above requirements include:

1. For GDC 2, the TBVS and SWBVS should conform to the guidance provided in RG 1.29, Regulatory Position C.1 for safety-related portions of the system and Regulatory Position C.2 for non-safety-related portions of the system.

2. For GDC 5, acceptance is based on the determination that sharing of TBVS and SWBVS structures systems and components in multiple-unit plants does not significantly impair their ability to perform their safety functions, including, in the event of an accident in one unit, an orderly shutdown and cooldown of the remaining unit(s).

3. For GDC 60, the TBVS and SWBVS should conform to the guidance of RG 1.52 and RG 1.140 as they relate to the design, inspection, testing and maintenance criteria for post-accident and normal atmosphere cleanup systems, ventilation exhaust systems, air filtration, and adsorption units of light-water-cooled nuclear power plants. The applicable regulatory position for RG 1.52, Revision 3 is C.3. The applicable regulatory positions for RG 1.140, Revision 2 are C.2 and C.3.

4. For 10 CFR 52.47(b)(1), the TBVS and SWBVS should conform to the guidance of RG 1.206, Section C.II.1, "Inspections, Tests, Analyses, and Acceptance Criteria," and that contained in SRP Sections 14.3, "Inspections, Tests, Analyses, and Acceptance Criteria"; and 14.3.7, "Plant Systems-Inspections, Tests Analyses and Acceptance Criteria."

9.4.4.4 *Technical Evaluation*

The staff reviewed the turbine island ventilation system and supporting FSAR Tier 2 information in accordance with SRP Section 9.4.4, Section III, "Review Procedures." In accordance with the SRP, the review focused on the system functional performance requirements and the methods and equipment provided for air treatment equipment for the system to determine whether the ventilation system or portions of the system have been designed or need to be designed as a safety-related system. The results and conclusions reached are as follows.

9.4.4.4.1 GDC 2

The guidance for GDC 2 is based on RG 1.29, Regulatory Positions C.1 for safety-related and C.2 for non-safety-related SSCs. FSAR Tier 1, Section 4.3 states that the COL applicant will provide design of the Switchgear Building, which would, therefore, include the design of the SWBVS. FSAR Tier 1, Section 4.4 states that the COL applicant will provide design of the Turbine Building, which would, therefore, include the design of the TBVS. In FSAR Tier 2, Section 9.4.4, the applicant states that the TBVS and the SWBVS components and RWBVS components are non-safety-related. The staff reviewed FSAR Tier 2, Table 3.2.2-1 "Classification Summary" (Sheets1−186). The staff finds that the TB, component code UMA, and the Switchgear Building (SWGB), component code UBA are assigned a Safety Classification as "NS-AQ" and Seismic Category as "Class II." The staff finds that the turbine island ventilation system, component codes SAM1, SAM2, SAC70, is designated non-safety-related and non-seismic. The staff reviewed the safety classification of SSCs in the TB and the SWB serviced by these HVAC systems and finds that there are no safety-related components that are served by or would be adversely affected by failure of these HVAC systems. Therefore, the staff finds that FSAR, Tier 2, Chapter 3 and FSAR Tier 2, Chapter 9 are consistent with regard to the safety and seismic classifications for the turbine island ventilation system. Accordingly, based on these classifications, the staff finds that RG 1.29, Regulatory Position C.2 applies to the TBVS and the SWBVS.

The staff reviewed the postulated design-basis accident scenarios and assumptions in FSAR Tier 2, Chapter 15. The staff finds that TBVS and the SWBVS components do not perform any safety-related function. Based on site layout of the U.S. EPR standard design the staff concludes that failure of TBVS and SWBVS components would not adversely affect any other safety-related system or cause injury to control room personnel. Therefore, the staff finds that RG 1.29, Regulatory Position C.2 would apply to these components. The staff finds that conformance to this regulatory position is to be confirmed via staff review of the COL information item supplied by an applicant that references the U.S. EPR standard design.

9.4.4.4.2 GDC 5, Shared Systems and Components Important to Safety

The staff reviewed the design of the TBVS and the SWBVS to ensure that the relevant requirements of GDC 5 are met.

GDC 5 governs the sharing of structures, systems, and components important to safety among nuclear power plant units in order to ensure such sharing will not significantly impair their ability to perform their safety functions. The U.S. EPR design is a single-unit station, and the requirements of GDC 5 are not applicable to the single-unit design.

9.4.4.4.3 GDC 60

GDC 60, control of releases of radioactive materials to the environment, requires that the nuclear power unit design include means to control suitably the release of radioactive materials in gaseous and liquid effluents and to handle radioactive solid wastes produced during normal reactor operation, including anticipated operational occurrences.

For the TBVS and the SWBVS, the staff reviewed FSAR Tier 1, Sections 4.3 and 4.4 and FSAR Tier 2, Section 9.4.4 as discussed below.

FSAR Tier 1, Section 4.3 states that the COL applicant will provide the design of the Switchgear Building, which would, therefore, include the design of the SWBVS. FSAR Tier 1, Section 4.4 states that the COL applicant will provide design of the Turbine Building, which would, therefore include the design of the TBVS. FSAR Tier 2 information is limited to a summary of the overall functions of the turbine island ventilation system. No further design information is provided for staff review such as the general arrangement of components or the numbers of fans, ventilation units, or subsystems utilized.

Based on the information supplied in FSAR, Revision 0, Tier 2, Section 9.4.4, the staff determined that insufficient detail was provided in the FSAR to determine if the TBVS and the SWBVS are in accordance with NUREG-0800, Section 9.4.4.The staff could not determine the functional requirements of the TBVS and the SWBVS in order to determine if the applicant must include any requirements for atmospheric cleanup or if any functions could be considered safety-related. Since the Turbine Building and the TBVS and the SWB and SWBVS, respectively, therein are not part of the design certification for the U.S. EPR, the paragraph in FSAR Tier 2, Section 9.4.4, which states that the TBVS is not used to process radioactive effluent is not verified by the staff. Portions of the systems could be considered safety-related if there is potential to encounter radioactive effluents. Therefore, in RAI 135, Question 09.04.05-1, Item #10, the staff requested that the applicant provide additional design information or criteria to assure compliance with the acceptance criteria defined in SRP Section 9.4.4. In a February 27, 2009, response to RAI 135, Question 09.04.05-1, Item #10, the applicant clarified that the turbine island ventilation system provides heating and ventilation to both the TB and SWB for normal operating modes, as well as during refueling outages. The TBVS consists of various systems and is designed to maintain equipment heat loads, personnel comfort, process extraction, and slightly positive building pressure in the Turbine Building.

The applicant re-iterated that the TBVS is not required to provide any accident response or radioactive effluent control for the U.S. EPR. In the event of a steam generator tube rupture, potentially contaminated steam would be discharged to the condensers where the air and noncondensable gases are removed by the condenser evacuation system, requiring no response from the TBVS. Thus, filtration of the Turbine Building atmosphere is not required and the TBVS performs no safety-related function.

The detailed design information requested by the staff was not provided by the applicant. The staff concluded that the FSAR Tier 1 interface requirement for a COL applicant to supply a Turbine Building and Electrical Switchgear Building design, would also include the TBVS design information that is required for a regulatory finding in this area. The staff determined that this information would not be available until the COL applicant provides the design of the Turbine

Building. Therefore, the staff determined the February 27, 2009, response to RAI 135, Question 09.04.05-1, Item #10, was unacceptable.

FSAR Tier 2, Revision 0, Table 1.8-2 did not list any COL information items related to FSAR Tier 2, Section 9.4.4, "Turbine Building Ventilation System." However, FSAR Tier 2, Section 1.8 indicated that the SWB and the TB are portions of the plant not submitted for certification. The staff determined that these building designs must include the TBVS design. FSAR Tier 1, Chapter 4 lists the design of the Turbine Building and the Switchgear Buildings as 10 CFR 52.47(a)(25) interface requirements.

The applicant has stated in its February 27, 2009, response to RAI 135, Question 09.04.05-1, Item 10, that since the TBVS is not safety-related; a specific COL interface requirement is not required for the final design of the TBVS. However, the staff is required to review an essentially complete design, prior to issuance of any COL that references the standard design. Since the TBVS and the SWBVS are part of the complete design of the plant as described in 10 CFR 52.47(c)(1), these systems must be reviewed by the staff in accordance with SRP Section 9.4.4, and sufficient information on these systems must be submitted either in the FSAR for the design certification or as information supplied by a COL applicant that references the standard design in order for the staff to make the required regulatory findings.

In RAI 277, Questions 09.04.04-1 and 09.04.04-2, the staff requested that the applicant clarify FSAR Tier 2 such that it is clear what COL information items are required for the design of the Turbine Building and Switchgear Buildings ventilation systems. As a minimum, a COL applicant should provide enough design details on the TBVS, as described in RG 1.206, such that the staff can come to required findings on the system detailed in SRP Section 9.4.4.

In an October 16, 2009, response to RAI 277, Questions 09.04.04-1 and 09.04.04-2, the applicant stated that FSAR Tier 2, Section 9.4.4 will be revised to state that the TBVS and the SWBVS are interface items to the standard design.

The staff reviewed FSAR Revision 2, with regard to additional design information, the applicant added COL Information Items 9.4-1 and 9.4-2 to FSAR Tier 2, Revision 2, Table 1.8-2. COL Information Item 9.4-1 requires a COL applicant referencing the U.S. EPR design certification to provide site-specific design information for the TBVS. COL Information Item 9.4-2 requires a COL applicant to provide site-specific design information for the SGBVS. These requirements were also reiterated in FSAR Tier 2, Section 9.4.4, which was also clarified to state the design functions of both the TBVS and SWBVS subsystems of the turbine island ventilation system.

The staff reviewed the October 16, 2009, response to Questions 09.04.04-1 and 09.04.2-2, and the Revision 2 FSAR changes and finds them acceptable because they clarify that it is the responsibility of a COL applicant that references the U.S. EPR design to provide design information on the TBVS and SWBVS sufficient for a staff review of these systems to be performed using the guidance of NUREG-0800, Section 9.4.4.

Accordingly, the staff finds that based on the stated design functions of the TBVS and SWBVS, both systems will not be designed to process radioactive effluent and are not intended to perform either as a normal or ESF atmospheric cleanup system and, therefore, the requirements of RG 1.52 or RG 1.140 would not apply to the turbine island ventilation system.

A design review of the turbine island ventilation system, which includes the TBVS and the SWBVS, in accordance with SRP Section 9.4.4 will be conducted as by the staff part of a COL application review. This review information provided by a COL applicant will confirm the system and component design standards, P&IDs, revised system functions, comply with NUREG-0800 guidance for and consequently will confirm if the COL design meets GDC 2 and GDC 60 requirements.

Accordingly, based on applicant's response to this RAI, the staff considers RAI 135, Question 09.04.05-1 (#10) resolved.

Additionally, based on the design functions of the turbine island ventilation system, as clarified in the October 16, 2009, response to RAI 277, Questions 09.04.04-1 and 09.04.04-2, the staff finds that the system is not designed to process radioactive effluents, and therefore GDC 60 would not apply.

The staff considers the FSAR statements relative to the TBVS and SWBVS with regard to safety functions and radioactive effluent control or filtering must be met by the COL applicant through the site-specific design of these interface items. Review of interface item design as it applies to the requirements of GDC 2, GDC 5, GDC 60 and the guidance of RG 1.206 with regard to the necessary level of detail for such systems and NUREG 0800, Section 9.4.4 will be performed by the staff via a review of TBVS and SWBVS design information provided in COL Information Items 9.4-1 and 9.4-2 in the COL design review.

9.4.4.4.4 ITAAC

ITAAC information is not provided for the turbine island ventilation system. The staff finds this acceptable because the system as described have been considered by the staff to be non-safety-related. The staff confirmation of this finding will be performed in COL reviews that reference the U.S. EPR standard design upon receipt of TBVS and SWBVS site-specific design information contained in COL Information Items 9.4-1 and 9.4-2. The staff finds that adequate inspections and tests for these systems as described, will addressed by COL Information Item 14.2-13, in the Initial Plant Test Program.

9.4.4.4.5 Technical Specifications

There are no Technical Specifications associated with the TBVS and SWBVS. The staff finds that this complies with NUREG-0800, Section 16 and NUREG-1431, "Standard Technical Specifications (STS) for Westinghouse Plants." The staff finds this acceptable because the system as described have been considered by the staff to be non-safety-related. The staff confirmation of this finding will be performed in COL reviews that reference the U.S. EPR standard design upon receipt of TBVS and SWBVS site-specific design information contained in COL Information Items 9.4-1 and 9.4-2.

9.4.4.4.6 Initial Plant Test Program

Initial plant testing requirements given for the turbine island ventilation system in FSAR Tier 2, Section 14.2, "Initial Plant Test Program," are Turbine island Ventilation Systems (Test #087), and the requirement to confirm the site-specific test as described in COL Information Item 14.2-13. The staff finds that a review of performance testing of the TBVS and SWBVS will be performed during the review of COL applications that reference the U.S. EPR standard design.

9.4.4.5 *Combined License Information Items*

The following is a list of items from FSAR Tier 2, Table 1.8-2. No other combined license information items related to the TBVS or SGBVS were noted by the staff.

Table 9.4.4-1 U.S. EPR Combined License Information Items

Item No.	Description	FSAR Tier 2 Section
9.4-1	A COL applicant that references the U.S. EPR design certification will provide site-specific design information for the turbine building ventilation system.	9.4.4
9.4-2	A COL applicant that references the U.S. EPR design certification will provide site-specific design information for the switchgear building ventilation system (SGBVS).	9.4.4
14.2-13	A COL applicant that references the U.S. EPR design certification will provide site-specific test abstract information for the turbine island ventilation systems	14.2.12.8.18

9.4.4.6 *Conclusions*

The TB, and its associated ventilation system and the SWB and its associated ventilation system are interfaces with the U.S. EPR standard design and are portions of the plant that are not submitted for certification. The staff reviewed information presented in the FSAR on the functional requirements of the turbine island ventilation system.

The U.S. EPR standard design TBVS and SWBVS were reviewed using the acceptance criteria guidance defined in NUREG-0800, Section 9.4.4. The staff concludes that the system, as described in the FSAR will be designed to comply with the requirements of GDC 2, and the requirements of GDC 60 will not apply because the TBVS is not a system that must process radioactive effluent. Since the U.S. EPR design is a single unit, GDC 5 is not applicable.

The site-specific design of the TBVS will be provided to the staff through the COL information item listed in FSAR Tier 2, Table 1.8-2. When a COL applicant submits a design for the TBVS and SWBVS, the staff will review the application in accordance with the guidance of RG 1.206 and NUREG 0800, Section 9.4.4. The staff's COL application review will confirm compliance with GDC 2, and 10 CFR 42.47(b)(1) and confirm that GDC 5 and GDC 60 do not apply.

9.4.5 Safeguard Building Controlled-Area Ventilation System (Related to NUREG-0800, Section 9.4.5, Engineered Safety Feature Ventilation System)

9.4.5.1 *Introduction*

Engineered safety feature ventilation systems (ESFVS) provides a controlled environment for engineered safety feature components and plant personnel during normal operation and following certain anticipated transients and design-basis accidents. The following FSAR Tier 2 sections describe ventilation systems which the staff considers subject to review under NUREG-0800, Section 9.4.5 review guidance for engineered safety feature ventilation systems:

9.4.5 The Safeguard Building Controlled-Area Ventilation System services the Safeguard Building hot mechanical areas where engineered safety feature components are located.

9.4.6 The Electrical Division of the Safeguard Building Ventilation System services electrical; instrumentation and control; and heating, ventilation, and air conditioning areas.

9.4.9 The Emergency Power Generating Building Ventilation System (EPGBVS) services the diesel hall, electrical room, and main tank room of each of the four divisions of the Emergency Power Generating Buildings (EPGBs).

9.4.11 The Essential Service Water Pump Building Ventilation System (ESWPBVS) services the essential service water system (ESWS) pump areas and associated electrical equipment areas.

The above four sections are reviewed under SRP Section 9.4.5.

9.4.5.2 *Summary of Application*

FSAR Tier 1: The FSAR Tier 1 information associated with this section is discussed in FSAR Tier 1, Sections 2.6.6, “Safeguard Building Controlled-Area Ventilation System”; 2.6.7, “Electrical Division of Safeguard Building Ventilation System”; 2.6.9, “Emergency Power Generating Building Ventilation System”; and 2.6.13, “Essential Service Water Pump Building Ventilation System,”

FSAR Tier 2: The applicant has provided system descriptions in FSAR Tier 2, Sections 9.4.5, “Safeguard Building Controlled-Area Ventilation System”; 9.4.6, “Electrical Division of Safeguard Building Ventilation System”; 9.4.9, “Emergency Power Generating Building Ventilation System”; and 9.4.11, “Essential Service Water Pump Building Ventilation System,”

ITAAC: ITAAC requirements are given in Table 9.4.5-1 below:

Table 9.4.5-1 ESFVS ITAAC Requirements

System	FSAR Tier 2, Section	FSAR Tier 1, ITAAC Requirements
SBVS	9.4.5	Table 2.6.6-3
SBVSE	9.4.6	Table 2.6.7-3
EPGBVS	9.4.9	Table 2.6.9-3
ESWPBVS	9.4.11	Table 2.6.13-3

Technical Specifications: Technical Specifications are as indicated in Table 9.4.5-2 below:

Table 9.4.5-2 ESFVS Technical Specifications

System	FSAR Tier 2, Section	FSAR Tier 2, Chapter 16 Technical Specifications
Safeguard Building Controlled-Area Ventilation System	9.4.5	3.7.12 B 3.7.12 5.5.10
Electrical Division of Safeguard Building Controlled-Area Ventilation System	9.4.6	3.7.13 B 3.7.13
Emergency Power Generating Building Ventilation System	9.4.9	None
Essential Service Water Pump Building Ventilation System	9.4.11	None

Preoperational Testing: Preoperational testing requirements given for the ESFVS in FSAR Tier 2, Section 14.2 are:

- Electrical Division of Safeguard Building Ventilation System (Test No. 078)
- Safeguard Building Controlled Area Ventilation System (Test No. 083)
- Emergency Power Generation Building Ventilation (Test No. 084)
- Essential Service Water Pump Building Ventilation System (Test No. 088)
- Ventilation Capability (Test No. 203)

9.4.5.3 *Regulatory Basis*

The relevant requirements of NRC regulations for this area of review, and the associated acceptance criteria, are given in NUREG-0800, Section 9.4.5, "Engineered Safety Feature Ventilation System," and are summarized below. Review interfaces with other SRP sections also can be found in NUREG-0800, Section 9.4.5.

1. GDC 2, as it relates to the system being capable of withstanding the effects of earthquakes.

2. GDC 4, as it relates to the ESFVS being appropriately protected against dynamic effects and being designed to accommodate the effects of and to be compatible with the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents.

3. GDC 5, as it relates to shared systems and components important to safety.

4. GDC 17, "Electric Power Systems," as it relates to ensuring proper functioning of the essential electric power system.

5. GDC 60, as it relates to the system being capable to suitably control release of gaseous radioactive effluents to the environment.

6. 10 CFR 50.63, as it relates to necessary support systems providing sufficient capacity and capability for coping with a station blackout event.

7. 10 CFR 52.47(b)(1), which requires that a design certification application contain the proposed ITAAC that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a plant that incorporates the design certification is built and will operate in accordance with the design certification, the provisions of the Atomic Energy Act of 1954, and NRC regulations.

Acceptance criteria adequate to meet the above requirements include:

1. For GDC 2, the ESFVS should conform to the guidance of RG 1.29, Regulatory Position C.1, for safety-related portions and Position C.2 for non-safety-related portions.

2. For GDC 4, the ESFVS should conform to the guidance of NUREG-0800, Sections 3.5.1.1, 3.5.1.4, 3.5.2, and 3.6.1 as they apply to the ESVS.

3. For GDC 5, acceptance is based on the determination that sharing of ESFVS structures systems and components in multiple-unit plants does not significantly impair their ability to perform their safety functions, including, in the event of an accident in one unit, an orderly shutdown and cooldown of the remaining unit(s).

4. For GDC 17, the ESVS should comply with the guidance of NUREG/CR-0660, "Enhancement of Onsite Emergency Diesel Generator Reliability," Item 2 under Subsection A, and Item 1 under Subsection C of the "Recommendations" for protection of essential electrical components from failure due to the accumulation of dust and particulate materials.

5. For GDC 60, the ESVS should conform to the guidance of RG 1.52 and RG 1.140 as related to design, inspection, testing, and maintenance criteria for post-accident and normal atmosphere cleanup systems, ventilation exhaust systems, air filtration, and adsorption units.

6. For 10 CFR 50.63, the ESVS should conform to the guidance of RG 1.155, including Regulatory Position C.3.2.4.

9.4.5.4 *Technical Evaluation*

The staff reviewed the FSAR and supporting FSAR Tier 2 information in accordance with SRP Section 9.4.5, Section III, and Review Procedures. The results and conclusions reached by the staff are as follows:

The staff reviewed the FSAR, including Tier 2, Table 3.2.2.1 in order to determine which U.S. EPR ventilation systems meet the definition of and engineered safeguards ventilation system. The staff reviewed the locations of ESF components as described in the FSAR and concludes the following U.S. EPR ventilation systems meet the definition of an engineered safety feature ventilation system: (a) SBVS; (b) SBVSE; (c) EPGBVS; and (d) ESWPBVS.

GDC 2, Design Basis for Protection Against Natural Phenomena

The staff finds the design of the ESFVS complies with GDC 2 regarding protection from the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, floods, and external missiles as follows. The Safeguard Buildings, Emergency Power Generating Buildings, Essential Service Water Pump Buildings, and Fuel Building that house the ESFVS are Seismic Category I designed structures that are also located and designed to provide protection from flood, hurricane/tornado winds, and missiles. The staff notes that FSAR Tier 2, Sections 3.3, 3.4, 3.5, 3.7, and 3.8 provide the bases for the adequacy of the structural design of these buildings with respect to natural phenomena.

Essential portions of the ESFVS, including the isolation dampers separating essential from nonessential portions, are classified Seismic Category I except as noted below.

Safeguard Building Controlled Area Ventilation System

In FSAR Tier 2 revision 1, Section 9.4.5.1, "Design Bases," the applicant stated that the SBVS is designed to Seismic Category I (per RG 1.29, Regulatory Position C.1) except for the following:

- Supply air ductwork which is classified as NS-AQ and designed to Seismic Category II requirements (per RG 1.29 Position C.2)

- Electric air heating convectors which are non-safety-related and non-seismic

FSAR Tier 2, Revision 1, Table 3.2.2-1 states that the SBVS fire dampers are NS-AQ and designed to Seismic Category II requirements. FSAR Tier 2, Revision 1, Figure 9.4.5-2 indicates that in addition to fire dampers, portions of the operational exhaust, and accident exhaust ducts are designed to Seismic Category II requirements.

The staff notes that the Seismic Category II classification of the fire dampers and associated ductwork in the SBVS supply, operational exhaust and accident exhaust duct system potentially provided for a common mode failure of all four SBVS divisions if an SSE or larger seismic event occurs. Components classified as Seismic Category II are designed not to fall and impact Seismic Category I components. However, since the fire dampers are not safety-related, they can be assumed to fail closed after a SSE or any other challenge to the system. The closure of the fire dampers isolates SBVS air supply and exhaust to hot mechanical areas potentially impacting the ability to achieve safe-shutdown. Therefore, in RAI 277, Question 09.04.05-2, the staff requested that the applicant either show that potential failure of these components will not reduce the safety function of the SBVS or classify the components as Seismic Category I.

In a February 28, 2011, response to RAI 277, Question 09.04.05-2, the applicant stated that the FSAR will be revised to reclassify the SBVS supply air ductwork to Quality Group C and Seismic Category 1 standards.

By revising the FSAR (Tier 1, Figure 2.6.6-1 and Tier 2, Section 9.4.5.1 and Figure 9.4.5-1), the applicant clarified that the SBVS supply ventilation ductwork had been reclassified as safety-related (Quality Group C) and Seismic Category I, and that SBVS fire dampers had also been reclassified as safety-related (Quality Group C) and Seismic Category I. The staff reviewed the FSAR changes related to the SBVS supply ventilation ductwork and finds them acceptable because they comply with the requirements of GDC-2.

In the FSAR change, the applicant also clarified that SBVS electric air heating convectors provided heating only for personnel comfort in stairwells and access areas during normal plant operation. The applicant further clarified that these heaters are not relied upon to maintain a minimum ambient design temperature for the Safeguard Building controlled area. The staff concurred that heaters for personnel comfort only can be non-safety-related. The staff also notes that stairwells and access areas typically do not house safety-related equipment. However, the staff determined that the applicant had not directly addressed the potential that failure of these heaters under SSE conditions might impact other safety components. Therefore, in RAI 277, Question 09.04.02-1, the staff requested that the applicant justify that failure of the non-safety heaters will not adversely impact safety-grade components, classify the heaters as Seismic Category II, or require the COL applicant to place the air heaters such that heater failure will not reduce the safety function of the SSC. **RAI 277, Question 09.04.02-1 is being tracked as an open item.**

The staff finds that the classification of SCVS components conforms to the guidance in RG 1.29, Regulatory Position C.1.for safety-related portions and RG 1.29, Regulatory Position C.2 for non-safety-related portions of the system. Therefore, the staff finds that the SBVS complies with the requirements of GDC 2.

Electrical Division of the Safeguard Building Ventilation System

In FSAR Tier 2, Section 9.4.6.1, “Design Bases,” the applicant states that the safety-related portion of the SBVSE is designed to Seismic Category I in accordance with RG 1.29, Regulatory Position C.1. Those non-safety-related portions of the SBVSE of which continued function is not required, but of which failure could reduce the functioning of any Seismic Category I system components to an unacceptable safety level, are designed to RG 1.29, Regulatory Position C.2.

The staff finds that FSAR Tier 2, Figures 9.4.6-1, “Safeguard Building Electrical Divisions 1 and 4 Air Intake,” and 9.4.6-2, “Safeguard Building Electrical Divisions 1 and 4 Air Supply and Exhaust,” clearly identify the breaks between safety-related and non-safety-related portions of the system. The staff finds that this meets the requirements of RG 1.29, Regulatory Position C.1.for safety-related portions and RG 1.29, Regulatory Position C.2 for non-safety-related portions of the system. Therefore, the staff finds that the SBVSE complies with the requirements of GDC 2.

Emergency Power Generating Building Ventilation System

The staff reviewed FSAR Tier 2, Section 9.4.9.1 and finds that the entire EPGBVS system is safety-related and classified as Seismic Category I. The staff finds that this meets the requirements of RG 1.29, Regulatory Position C.1. Therefore, the staff finds that the SBVSE complies with the requirements of GDC 2.

Essential Service Water Pump Building Ventilation System

The staff reviewed FSAR Tier 2, Section 9.4.11.1 and finds that the entire ESWPBVS system is safety-related and classified as Seismic Category I (FSAR Tier 2, Section 9.4.11.1). The staff finds that this meets the requirements of RG 1.29, Regulatory Position C.1. Therefore the staff finds that the ESWPBVS meets the requirements of GDC 2.

Therefore, based on the above, the staff finds that the applicant complies with the requirements of GDC 2 with respect to the ESFVS being capable of withstanding the effects of earthquakes by conforming to the guidelines of RG 1.29, Regulatory Position C.1 for safety-related portions of the system and RG 1.29, Regulatory Position C.2 for non-safety-related portions.

GDC 4, Environmental and Dynamic Effects Design Basis

Based on review of information in the FSAR the staff finds that the SBVSE, EPGBVS, and ESWPBVS each consist of four divisions and are fully redundant. For the SBVSE, a maintenance train provides the SBVSE functions during periods of maintenance. Similarly, the SBVS consists of four redundant ventilation divisions and two iodine filtration trains (which are aligned only in the event of an airborne radiation signal in the FB or a containment isolation signal). Each system requires only one division to function following a design-basis accident (DBA). Each of the four trains is physically separated; therefore, only one train can be physically affected by an internal hazard (fire, flood, or pipe break). There is no credible single failure which will cause these systems not to provide the required cooling and ventilation capacity. This redundancy is such that one system may be taken out of service for maintenance or testing without impacting the function of the entire system. For the SBVSE, the availability of both iodine filtration trains is assured by the requirements of TS 3.7.12.

In the event of a loss of offsite power, the emergency diesel generators provide power to:

- SBVS and SBVSE dampers in Safeguard Building Divisions 1 through 4
- SBVS accident exhaust iodine filter trains (Divisions 3 and 4) Train 30KLC42
- SBVS accident exhaust iodine filter trains (Divisions 1 and 2) Train 30KLC41
- SBVSE normal supply fans in Divisions 1 through 4
- SBVSE exhaust fans in Divisions 1 through 4
- SBVSE recirculation fans in Divisions 1 through 4
- EPGBVS fans and actuators in Divisions 1 through 4
- ESWPBVS fans and actuators in Divisions 1 through 4
- Each EDG supplies power to its corresponding division components.

The worst case single failure of an EDG (Division 3 or 4) will cause the loss of that division and one SBVS accident exhaust iodine filter train. Since each of the ESFVS divisions is fully redundant, the required system capacity is maintained.

Safeguard Building Controlled Area Ventilation System

In FSAR Tier 2, Sections 3.5.1.4, 3.5.2, and 9.4.5.1, the applicant states that the SBVS is located inside the Safeguard Building that is designed to withstand the effects of natural phenomena, such as earthquakes, tornados, hurricanes, floods, and external missiles.
The analysis of a postulated high-energy line failure is provided in FSAR Tier 2, Sections 3.6.1, "Plant Design for Protection Against Postulated Piping Failures in Fluid Systems Outside of Containment," and 3.6.2, "Determination of Rupture Locations and Dynamic Effects Associated with the Postulated Rupture of Piping." In FSAR Tier 1, Section 2.6.6 (6.1), the applicant states that the electrical equipment given in FSAR Tier 1, Table 2.6.6-2, "Safeguard Building

Controlled-Area Ventilation System Equipment I&C and Electrical Design," can perform their safety function following exposure to the design-basis environments for the time required. Refer to FSAR Tier 2, Section 3.11, "Environmental Qualification of Mechanical and Electrical Equipment," for equipment qualification.

In FSAR Tier 2, Section 9.4.5.1, the applicant states the SBVS vents and louvers are supplied by the SBVSE for supply and the NABVS for exhaust air. The SBVS vents and louvers are protected from external missiles by locating these components within the Safeguard Building and providing protection from internal missiles by meeting the requirements of FSAR Tier 2, Section 3.5.1.1, "Internally Generated Missiles Outside Containment."

Based on the above FSAR statements, the staff finds that SBVS appropriately addresses adverse environmental conditions and dynamic effects in the design of the system and, therefore, complies with the requirements of GDC 4.

Electrical Division of the Safeguard Building Ventilation System

In FSAR Tier 2, Sections 3.5.1.4, 3.5.2, and 9.4.6.1, the applicant states that the SBVSE is located inside the Safeguard Building, which is designed to withstand the effects of natural phenomena, such as earthquakes, tornados, hurricanes, flood, and external missiles. Based on the staff's review of FSAR Tier 2, Table 3.6.1-2, "Building, Room, and Postulated Pipe Ruptures," and FSAR Tier 2, Table 3.11-1, "List of Environmentally Qualified Electrical/I&C Equipment," the staff concludes that the SBVSE and SSCs serviced by the SBVSE are located in mild environments and are not located in an area with postulated pipe ruptures. Based on the above FSAR review, the staff finds that the SBVSE appropriately addresses adverse environmental conditions and dynamic effects in the design of the system and, therefore, complies with the requirements of GDC 4.

Emergency Power Generating Building Ventilation System

In FSAR Tier 2, Sections 3.5.1.4, 3.5.2, and 9.4.9.3, "Safety Evaluation," the applicant states that the EPGBVS is located inside the Emergency Power Generating Buildings that are designed to withstand the effects of natural phenomena, such as earthquakes, tornados, hurricanes, floods, and external missiles).

Based on the staff's review of FSAR Tier 2, Table 3.6.1-2, and FSAR Tier 2, Table 3.11-1, the staff concludes that the EPGBVS and SSCs serviced by the EPGBVS are located in mild environments and are not located in an area with postulated pipe ruptures.

Based on the above FSAR review, the staff finds that the EPGBVS appropriately addresses adverse environmental conditions and dynamic effects in the design of the system and, therefore, complies with the requirements of GDC 4.

Essential Service Water Pump Building Ventilation System

In FSAR Tier 2, Sections 3.5.1.4, 3.5.2, and 9.4.11.3, the applicant states that the ESWPBVS is located inside the Essential Service Water Pump Building (ESWPB) that is designed to withstand the effects of natural phenomena, such as earthquakes, tornados, hurricanes, floods, and external missiles).

Based on the staff's review of FSAR Tier 2, Table 3.6.1-2, and FSAR Tier 2, Table 3.11-1, the staff concludes that the ESWPBVS and SSCs serviced by the ESWPBVS are located in mild environments and are not located in an area with postulated pipe ruptures.

Based on the above FSAR review, the staff finds that the ESWPBVS appropriately addresses adverse environmental conditions and dynamic effects in the design of the system and therefore complies with the requirements of GDC 4.

- Based on the above, the staff concludes the design of the safety-related portions of the ESFVS comply with the environmental requirements of GDC 4 regarding potential dynamic effects, such as pipe whip, jet impingement, and missile impacts caused by equipment failure or events outside the plant.

GDC 5, Sharing of Structures, Systems, and Components

The staff reviewed the design of the SBVS, SBVSE, EPGBVS, and the ESWPBVS to ensure that the relevant requirements of GDC 5 are met.

GDC 5 governs the sharing of structures, systems, and components important to safety among nuclear power plant units in order to ensure such sharing will not significantly impair their ability to perform their safety functions. The U.S. EPR design is a single-unit station, and the requirements of GDC 5 are not applicable to the single-unit design.

GDC 17 – Electric Power Systems

FSAR Tier 2, Table 8.1-1, "Acceptance Criteria and Guidelines Applicability for Electric Power Systems," shows that essential electrical equipment conform to the guidelines of NUREG/CR-0660, which includes the use of seals or gaskets on electrical cabinets; and ventilation louvers are equipped with filters.

SBVS and SBVSE

FSAR Tier 2, Section 9.4.9.1, "Design Basis," states: "The EPGBVS maintains acceptable temperatures and air renewals in each of the four divisions to support operation of the emergency diesel generators (EDG) and electrical control panels". Based on this statement, the staff considers the EPGBVS an Engineered Safety Feature Ventilation System. NUREG-0800, Section 9.4.5 is used by the staff to review such systems. Section II of this SRP "Acceptance Criteria" states that such systems are subject to GDC 17. GDC 17, Part III "Review Procedures states:

> The ESFVS is reviewed to ensure that adequate means is provided in the system design for control of airborne particulate material (dust) accumulation. The system arrangement is reviewed to verify that a minimum of seven meters (20 feet) exists from the bottom of all fresh air intakes to grade elevation, or that electrical cabinets are provided with suitable seals or gaskets.

There is currently sufficient information in the FSAR for the staff to review this criterion and make a finding with respect to GDC 17; however, the design basis section of the EPGBVS description does not declare GDC 17 as a design criterion. Therefore, in RAI 461, Question 09.04.05-4, the staff requested that the applicant state in FSAR Tier 2, Section 9.4.9.1 that the design is subject to GDC 17, and summarize how the requirements of GDC 17 have been met. **RAI 461, Question 09.04.05-4 is being tracked as an open item.**

In FSAR Tier 2, Sections 9.4.5.1 and 9.4.6.1, the applicant states that the essential electrical equipment serviced by SBVS and SBVSE are protected from dust accumulation through the use of roughing prefilters and filters in each supply air train of the SBSVE. The bottom of SBVSE inlets are a minimum 6.1 m (20 ft) from grade.

EPGBVS

Based on the review of FSAR Tier 2, Section 9.4.9 and review of Figure 9.4.9-1, “Emergency Power Generating Building Ventilation System” the staff finds that the essential electrical equipment serviced by EPGBVS is protected from dust accumulation using prefilters and HEPA filters of the electrical room air conditioning unit (. Based on the staff’s review of FSAR Tier 2, Figures 3.8-89 through 3.8-94, the staff finds that the fresh air intake is a minimum 15.2 m (50 ft) above grade.

ESWPBVS

Based on the staff’s review of FSAR Tier 2, Section 9.4.11.1, “Design Bases,” the staff finds that ESWPBVS does not filter outside air prior to supplying the essential electrical equipment. However, the applicant states the electrical power systems meet the guidance of NUREG/CR-0660 (Subsection A − Item 2, and Subsection C − Item 1) for protection of essential electrical components from failure due to the accumulation of dust and particulate materials.

Therefore, based on the above, the staff finds the design of the safety-related portions of the ESFVS complies with GDC 17 regarding the protection of essential electrical components from failure due to the accumulation of dust and particulate materials.

GDC 60, Control of Releases of Radioactive Materials to the Environment

EPGBVS and ESWPBVS

The EPGBVS and ESWPBVS are not expected to contain or interface with any radioactive materials; they have no atmospheric radioactive-contamination clean-up functions, therefore, they are not subject to the requirements of GDC 60 and the guidance of RG 1.140. Based on review of the layout of the U.S. EPR design, the staff finds that these systems are located in separate buildings from potentially contaminated areas and are not expected to contain or interface with any radioactive materials therefore these systems are not subject to the requirements of GDC 60.

SBVS and SBVSE

The FSAR describes the Safeguard Buildings as being divided into clean and radiologically controlled areas, which are potentially contaminated. During normal operation, the controlled area is exhausted by the non-safety-related NABVS. During a design basis accident, these controlled areas are serviced by the SBVS. The balance of the Safeguard Building is serviced by the SBVSE supply and exhaust. That staff determined that FSAR Tier 2, Section 9.4.6.1 does not state that that SBVSE is subject to GDC 60. FSAR Tier 2, Section 9.4.6.2.1 states that the SBVSE contains connections providing air to the mechanical controlled areas. FSAR Tier 2, Section 3.8.4.1.3 states that the lower levels of the Safeguard Buildings, which contain the mechanical equipment, and the upper levels of the Safeguard Buildings contain electrical equipment. Cable pipe and duct shafts are located within the Safeguard Buildings for routing distribution between the various elevations of the buildings. Based on this review, in RAI 461, Question 09.04.05-3, the staff requested that the applicant provide the following information:

1. Please justify why the SBVSE is not subject to GDC 60. i.e., please describe in the FSAR, or clarify where it is described in the FSAR, what controls separate contaminated areas from clean areas in the safeguards buildings.

   a. The justification should include a general discussion of what controls exist to prevent the migration of contamination from contaminated areas to clean areas of the Safeguard Building. (Areas serviced by the SBVS to areas serviced by the SBVSE).

   b. The justification should specifically address how the SBVSE would function in the event of a RCP thermal barrier failure, or escape of contamination contained within the CCW system.

   c. Alternatively, clarify that the SBVSE is subject to GDC 60, and provide appropriate justification.

   d. Alternatively, clarify how the NABVS or the SBVS or other atmosphere cleanup system could be utilized with the SBVSE to clean up the SBVSE atmosphere if required.

2. Figure 9.4.6.1 Safeguards Building Electrical Divisions 1 and 4 air intake is missing the supply air fan. Please add the symbol to the drawing.

RAI 461, Question 09.04.05-3, which is associated with the above request, is being tracked as an open item.

Except for the open item above, the staff finds that the SBVSE service portions of the Safeguard Building are not expected to contain or interface with any radioactive materials; therefore, the SBVSE has no atmospheric radioactive-contamination clean-up functions and, therefore, is not subject to the requirements of GDC 60 and the guidance of RG 1.140.

Normal exhaust and atmospheric cleanup for the SBVS radiologically controlled areas is provided by the NABVS, as discussed in FSAR Tier 2, Section 9.4.3.

Section 9.4.3 of this report documents the staff's review of the NABVS against RG 1.140. As stated in this section, the staff finds that the NABVS conforms to meets the guidance of RG 1.140, Regulatory Positions C.2 and C.3.

In FSAR Tier 2, Section 9.4.5.1, the applicant states that the SBVS controls the release of radioactive materials by conforming to the guidance of RG 1.52, Revision 3, Regulatory Position C.3.

During normal operation, the dual in-series, isolation dampers in each supply, and exhaust duct are in the open position, and the volume control dampers in each duct are set to maintain negative pressure in the controlled areas. The accident air exhaust isolation dampers are also in the open position, and the iodine filtration trains located in the FB are in a standby mode. Isolation dampers for switching the fuel handling accident exhaust from both the FB and the Containment Building are in the closed position.

On receipt of a containment isolation signal, high radiation in the RB or high radiation in the Safeguard Building signal, the normal supply and exhaust dampers close, and the accident exhaust iodine filtration trains are placed in operation.

In the accident exhaust mode, exhaust air from each Safeguard Building Division is combined and discharged through a common concrete duct in the annulus, which connects to two accident iodine exhaust filtration trains located in the FB. Each 100 percent capacity iodine filtration train consists of inlet and outlet dampers, prefilter/moisture separator, preheater, inlet and outlet HEPA filters, activated carbon iodine adsorber, exhaust fan, and backdraft damper. The fans direct the exhaust air to the plant stack. The staff finds that this configuration conforms to the guidance in RG 1.52, Revision 3, Regulatory Position C.3.

In FSAR Tier 2, Section 9.4.5.2.3, "System Operation," the applicant states that the system can also be aligned for atmospheric cleanup following:

- Radiation leak from equipment in one of the Safeguard Buildings controlled areas
- Fuel handling accident in the Fuel Building
- Fuel handling accident in the Reactor Building
- Section 6.5.1 of this report documents the staff review of The SBVS accident filtration system (moisture separator, filter air heater, preflters HEPA filters Adsorbers) against RG 1.52. As stated in this section the staff finds that the SBVS complies with the guidance in SRP Section 6.5.1 for ESF filter systems and conforms to the guidance of RG 1.52.

For the balance of the SBVS (instrumentation, ductwork, heaters fans, dampers, etc.), the staff reviewed FSAR Tier 2, Section 9.4.5.2.2 and finds that these descriptions conform to the guidance of RG 1.52, Regulatory Position C.2.

Since the staff finds that the SBVS accident exhaust filtration trains conform to the guidance of RG 1.52 and the NABVS performs normal atmosphere cleanup function for the Safeguard Building's radiologically controlled areas and conforms to the guidance of RG 1.140, the staff concludes, that the SBVSE complies with the requirements of GDC 60 with regard to the design, inspection, testing, and maintenance criteria for post-accident atmosphere cleanup systems, ventilation exhaust systems, air filtration, and adsorption units. The staff's review of the SBVS accident exhaust filtration train components and the NABVS are discussed in Section 6.5.1 and Section 9.4.3 of this report.

Except for the open item discussed above, since the staff finds that the SBVSE supply isolates from radiologically controlled areas of the Safeguard Building, and since the non-controlled areas do not contain sources of potential contamination, the staff finds that the SBVSE does not perform either a normal or post accident atmospheric cleanup function. Therefore, the staff finds that the requirements of GDC 60 with regard to the design, inspection, testing, and maintenance criteria for post accident atmosphere cleanup systems, ventilation exhaust systems, air filtration, and adsorption units does not apply to the SBVSE.

10 CFR 50.63, Station Blackout

In the event of station blackout, the SBODGs provide alternate ac to Division 1 and 4 electrical components.

SBVS and SBVSE

In FSAR Tier 2, Section 8.4, “Station Blackout,” the applicant states that the SBODGs supply power to SBVS supply air control dampers and to the recirculation cooling units in Safeguard Building Divisions 1 and 4 to provide cooling to residual heat removal, safety injection, hydrogen monitoring and severe accident sampling system components.

In FSAR Tier 2, Section 9.4.6.1, “Design Bases,” the applicant states that the recirculation cooling units, air coolers, and safety chilled water system in SBVSE Divisions 1 and 4 are also powered by the SBO diesel. Therefore, the staff finds that during an SBO, the SBSVE and the SBVS would maintain acceptable temperature and air quality in two of the four safeguards buildings.

EPGBVS

FSAR Tier 2, Section 9.4.9.2.3, “System Operation,” states that during an SBO, the emergency diesels are not operating, and there are no other significant heat loads; therefore, the EPGBVS is not required.

ESWPBVS

FSAR Tier 2, Section9.4.11.2.3, “System Operation,” states that in the event of an SBO, the SBO diesels supply power to the ESWPBVS to maintain adequate ventilation to the ESW pump area and the associated electrical equipment. Cooling coils supplied by ESW provide area cooling.

In FSAR Tier 2, Section 8.4.2.6.2, “RG 1.155 C.3.2 – Evaluation of Plant-Specific Station Blackout Capability (Station Blackout Coping Capability)”), the applicant states the capability for withstanding or coping with a station blackout is based on meeting the guidance of RG 1.155, Regulatory Position C.3.2.4.

Based on the above FSAR statements, the staff finds the design of the ESFVS complies with 10 CFR 50.63 regarding the capability for responding to a station blackout, because in the event of an SBO, the EPGBVS has no significant heat load. The remaining ESFVS would be powered by the SBODG and, would therefore, have power to continue to function to maintain acceptable conditions in two of the four safeguards buildings and in the ESW Pump Building. Thus, ESF equipment located in these locations is not expected to endure environmental conditions that would result from a loss of heating, ventilation and air conditioning.

Technical Specifications

Technical specification and surveillance requirements for ESFVS (FSAR Tier 2, Chapter 16) were reviewed by the staff and are discussed as follows:

SBVS

SBVS is addressed in proposed FSAR Tier 2, Chapter 16, Technical Specifications 3.7.12, “Safeguard Building Controlled Area Ventilation System,” and B 3.7.12, “Safeguard Building Controlled Area Ventilation System. The staff finds the technical specifications acceptable, because the design bases were correctly translated into the specifications. SBVS must be operable in Modes 1, 2, 3, and 4.

The staff notes that Technical Specification TS 3.7.12 (SBVS) provides a 7-day limiting condition for operation with one of the two iodine-filtration exhaust train out of service, a 24-hour LCO with both exhaust filtration trains out of service (OOS) due to inoperable fuel building boundary, and a requirement to be in Mode 3 within the 36 hours if both exhaust filtration trains are OOS for other reasons. The staff finds these limitations acceptable in assuring the availability of iodine filtration capabilities.

FSAR Tier 2, Chapter 16, Surveillance Requirement 3.7.12.6 verifies the ability of the system to draw down the Safeguard Building and Fuel Building to a negative pressure > 0.062 kPa (0.25 in. water) gauge in a specific time using one SBVS accident exhaust filtration train.

FSAR Tier 2, Chapter 16, Surveillance Requirement 3.7.12.7 verifies the ability of the system to maintain the Safeguard Building and Fuel Building at a negative pressure > 0.062 kPa (0.25 in. water) gauge using one SBVS accident exhaust filtration train operating at specified air flow rate. The staff finds these surveillances acceptable because they ensure that the capability to adequately draw down and maintain a negative pressure in the FB and Safeguard Building controlled areas is periodically verified.

SBVSE

SBVSE is addressed in proposed FSAR Tier 2, Chapter 16, Technical Specifications 3.7.13, “Safeguards Building Ventilation System Electrical Division,” and B 3.7.13, “Safeguards Building Ventilation System Electrical Division.” The staff finds these proposed technical specifications acceptable, because the design bases were correctly translated into the specifications. SBVSE must be operable in Modes 1, 2, 3, and 4.

FSAR Tier 2, Chapter 16, Surveillance Requirement 3.7.13.2 verified the capability of the system to remove the design heat load. The staff finds this surveillance acceptable because it ensures that the capability of the SBVSE to maintain acceptable temperatures in those spaces that contain safety-related equipment is periodically verified.

EPGBVS and ESWPBVS

EPGBVS and ESWPBVS are not addressed in proposed technical specifications. A review of NUREG-1431, “Standard Technical Specifications Westinghouse Plants,” Volume 1 & 2 Revision 3.0 shows that systems similar to the EPGBVS and ESWPBVS are not included in the standard technical specifications. There are technical specifications for the essential service water system and the emergency alternating current sources of power. Technical Specification 3.7.8 requires the essential service water systems to be operable, and Technical Specification 3.8.3 requires the emergency alternating current power supplies to be operable. Section 1, of technical specifications defines operability to include “all necessary attendants … auxiliary equipment that are required for the system, subsystem, train, component, or device to perform its specified safety function are also capable of performing their related support function.” As a result, the staff finds that specific technical specifications on the EPGBVS and the ESWPBS are not necessary.

ITAAC

The staff reviewed the ITAAC requirements in FSAR Tier 1, Tables 2.6.6-3, “Safeguard Building Controlled-Area Ventilation System ITAAC,” 2.6.7-3, “Electrical Division of Safeguard Building Ventilation System ITAAC,” 2.6.9-3, “Emergency Power Generating Building Ventilation System

ITAAC," 2.6.13-3, "Essential Service Water Pump Building Ventilation System ITAAC," and FSAR Tier 2, Section 14.3.

One of the safety-related functions of the SBVSE described in FSAR Tier 2, Section 9.4.6 is to maintain hydrogen concentration below allowable limits. Based on a review of Revision 2 of the FSAR, the staff determined that Tier 1 states that the Electrical Division of the Safeguards Building Ventilation System provides the safety-related function of providing ventilation for the battery rooms, and Hydrogen concentrations are to remain below "allowable limits during accident conditions." However, the staff that existing ITACC tables have line items solely for verification of battery room temperature alarms, displays and controls. There exists an ITAAC requirement to (1) verify battery room coil size via inspection and (2) Perform a test to verify room is maintained between specified limits, verify outside air supply fan flow rate and recirculation flow rate are at specified values.

The staff determined that there is no proposed ITAAC for the Tier 1 design commitment to maintain hydrogen control below any numerical criteria. In addition, FSAR Tier 2, Section 9.4.6 does not describe how this safety-related design basis function is achieved, nor reference associated NRC guidance such as RG 1.128.

The NRC staff considers that hydrogen concentration should be maintained below allowable limits both during normal and accident conditions. Therefore, in RAI 461, Question 09.04.01-3, the staff requested that the applicant clarify the following.

1. How hydrogen control will be accomplished during both normal and during accident conditions.

2. What are the design basis allowable limits are for the battery rooms, and how these limits were established. Clarify how applicable regulatory guidance (RG 1.128) was used to establish these limits.

3. Describe the verification program that will assure the system's capability to control hydrogen concentration.

4. Propose an ITAAC to demonstrate, via test or analysis, that the exhaust ventilation from the battery rooms is sufficient to assure that acceptable hydrogen concentrations are maintained. Define specific acceptance criteria.

Revise FSAR Tiers 1 and 2 as appropriate.

RAI 461, Question 09.04.01-3 is being tracked as an open item.

Except for the open item above, the staff finds the ITAAC acceptance criteria for SBVS, SBVSE, EPGBVS, and ESWPBVS appropriate, and therefore, finds the ITAAC requirements acceptable in complying with the requirements of 10 CFR 52.47(b) (1).

Preoperational Testing

Preoperational testing requirements given for the ESFVS in U.S. FSAR Tier 2, Section 14.2 are:

- Electrical Division of Safeguard Building Ventilation System (Test No. 078)

- Safeguard Building Controlled-Area Ventilation System (Test No. 083)

- Emergency Power Generation Building Ventilation (Test No. 084)
- Essential Service Water Pump Building Ventilation System (Test No. 088)
- Ventilation Capability (Test No. 203) [Note: Test #203 applies to the Safeguard Building and ESW Pump Building ventilation systems]

The staff reviewed these tests, and finds them acceptable for verifying the systems will perform as stated in FSAR Tier 2, Sections 9.4.5, 9.4.6, 9.4.9, and 9.4.11.

9.4.5.5 *Combined License Information Items*

There are no COL information items related to this area of review. The staff concludes that there are no additional items needed for this area of review.

9.4.5.6 *Conclusions*

Except for the open item in RAI 277, Question 09.04.02-1, the staff concludes that sufficient information has been provided by the applicant in the FSAR on the design and operation of the ESF ventilation systems, and the systems can perform their safety functions under post-accident conditions including a postulated single active failure.

The staff concludes that the design of the ESFVS presented in FSAR Tier 1, Revision 2, Sections 2.6.6, 2.6.7, 2.6.9, 2.6.13; and FSAR Tier 2, Sections 9.4.5, 9.4.6, 9.4.9, 9.4.11, comply with the requirements of GDC 2 and GDC 4. Since the U.S. EPR design is a single unit, GDC 5 is not applicable.

Except for the open item in RAI 461, Question 09.04.05-4, the staff finds that the ESF ventilation systems meet the requirements of GDC 17.

The staff concludes that the SBVS meets the requirements of GDC 60. Except for the open item in RAI 461, Question 09.04.05-3, for the SBVSE, the staff finds that since the ESWPB, the EPGB, and the SBVSE do not contain, and are not expected to interface with radioactive materials, GDC 60 is not applicable to the ESWPBVS and the EPGBVS and the SBVSE. The staff finds that the SBVS, SBVSE, and the ESWPBVS comply with the requirements of 10 CFR 50.63. Additionally, because the EDGs are not required to function in an SBO, requirements of 10 CFR 50.63 does not apply to the EPGBVS.

The staff concludes that the ITAAC and Technical Specification requirements will ensure that the ESFVS can be properly inspected, tested, and operated in accordance with the design basis as described in the FSAR and, therefore, consider that the ESFVS design complies with 10 CFR 52.47(b) (1).

9.4.6 Electrical Division of Safeguard Building Ventilation System

The staff has performed its review of the SBVSE in section 9.4.5 of this report.

9.4.7 Non-Safety-Related Atmospheric Cleanup Systems

The Non-Safety-Related Atmospheric Cleanup Systems are described in the following FSAR Tier 2, Sections:

- 9.4.7, “Containment Building Ventilation System”
- 9.4.10, “Station Blackout Room Ventilation System” (SBORVS)
- 9.4.12, “Main Steam and Feedwater Valve Room Ventilation System” (VRVS)
- 9.4.13, “Smoke Confinement System” (SCS)
- 9.4.14, “Access Building Ventilation System” (ABVS)

9.4.7.1 *Introduction*

The function of the non-safety-related atmospheric cleanup systems is to provide ventilation, permit personnel access, and maintain equipment operating temperatures in the Containment Building, Station Blackout Room, main steam and feedwater valve room, and Access Building. The CBVS and VRVS are operational during normal plant conditions and planned shutdowns. The SBORVS is operational during all plant operating conditions. The ABVS is operational during normal plant conditions, planned shutdowns, and anticipated operational occurrences. The SCS is normally switched off and remains in standby mode in the event of a fire. The function of the smoke confinement system is to mitigate the effects of smoke or gases that could result from a fire in the NI buildings during operation of the fire protection system.

9.4.7.2 *Summary of Application*

FSAR Tier 1: The containment building ventilation system FSAR Tier 1 sections are identified in FSAR Tier 1, Section 2.6.8, “Containment Building Ventilation System.” The functional arrangement for the CBVS is shown in FSAR Tier 1, Figure 2.6.8-1, “Containment Building Ventilation System Functional Arrangement,” and the location of the equipment is given in FSAR Tier 1, Table 2.6.8-1, “Containment Building Ventilation System Containment Isolation Valves Mechanical Design.”

There are no FSAR Tier 1 entries for the SBORVS (FSAR Tier 1, Section 2.6.14), VRVS (FSAR Tier 1, Section 2.6.12), SCS (FSAR Tier 1, Section 2.6.11), and ABVS (FSAR Tier 1, Section 2.6.2).

FSAR Tier 2: FSAR Tier 2, Section 9.4.7states that the containment penetration valves and low-flow purge filtration system are classified as safety-related and Seismic Category I. The reactor pit cooling fans and internal filtration components are classified as non-safety-related and Seismic Category I. The remaining components of the CBVS are classified as non-safety-related and non-seismic. The CBVS provides conditioned air to the Containment Building, service compartments, and equipment compartments. In addition, the CBVS provides the following safety-related and non-safety-related functions:

Safety-Related

- Upon receipt of a containment isolation signal, the CBVS provides automatic isolation of the containment atmosphere by quick closure of the containment isolation valves upon receiving a containment isolation signal.
- Upon receipt of a containment isolation signal during a low flow purge operation, air exhausted from containment will be filtered by the CBVS low flow iodine filtration units until the containment isolation valves are closed.

Follow up comment to RAI 277, Question 09.04.03-3

Based on your response to RAI 277, Question 09.04.03-3, the staff understands that only the containment low-flow purge exhaust subsystem outside of containment is designated as safety-related, Seismic Category 1, ESF ventilation system. Therefore the staff requests you clarify the following in the FSAR:

1. Clarify FSAR Tier 1 Section 2.6.9. Here you state "The CBVS low flow purge exhaust to iodine filtration trains" as a CBVS safety-related function. Specify in Tier 1 from what ventilation system or space the CBVS low-flow purge exhaust filtration trains would function.
2. Clarify FSAR Tier 2 Revision 2 paragraph 9.4.7.1. This paragraph is unclear in the following ways:

    a. The paragraphs could be inferred to mean that containment atmosphere cleanup via the low-flow purge exhaust subsystem is a CBVS safety-related function. The staff understands that this is not the intent of the design based on the accompanying figure, 9.4.7-2 that shows that the ductwork inside containment is not designed to be functional after a SSE, however the clarification to the paragraph made in response to RAI 277 Question 09.04.03-1 is not sufficient to clarify what the safety-related function of the CBVS is in this regard.

    b. The added sentence: "The containment low-flow purge exhaust subsystem outside of Containment is designated as a safety-related Seismic Category 1, ESF ventilation system" Conflicts with Section 9.4.7.3 of the FSAR which states that "The CBVS is not an engineered safety feature and has no safety-related function except the containment isolation and low-flow purge"

3. Also the staff must review the CBVS ductwork, dampers and fans that are located outside containment against criteria for ESF filter systems described in NUREG-0800, Section 6.5.1. These components are described in FSAR Tier 2, Section 9.4.7.2.2. As stated in related RAIs, since you are taking exception to RG 1.52 as it applies to ASME AG-1-1997 and ASME-1a-2000 addenda as it is referenced in the regulatory positions of that regulatory guide, revise these FSAR component descriptions to specifically address the several regulatory positions under RG 1.52 positions C.2, C.3 and C.4 and C.5 as they apply to each component (Fans, Ductwork and Dampers etc).

Non-Safety-Related

- The CBVS provides containment full flow purge supply and exhaust during plant outages.
- The CBVS provides low flow purge supply for containment entry during normal plant operation.
- The CBVS provides internal filtration to reduce the radioactive contamination inside the equipment compartment.
- The CBVS supplies cool air to the reactor pit to prevent concrete degradation.
- The CBVS provides containment cooling to maintain ambient conditions.

- The CBVS supports RCPB leakage detection

The SBORVS (described in FSAR Tier 2, Section 9.4.10) is classified as non-safety-related and non-seismic. The SBORVS provides conditioned air to the station blackout diesel generator Divisions 1 and 2, diesel hall, fuel tank room, and associated electrical rooms.

The VRVS (described in FSAR Tier 2, Section 9.4.12) is classified as non-safety-related, Seismic Category II and not required to operate during a design-basis accident. The VRVS provides conditioned air to the main steam valve rooms, feedwater valve rooms, and steam generator blowdown valve room.

The SCS (described in FSAR Tier 2, Section 9.4.13) is classified as non-safety-related, non-seismic, and not required to operate during a design-basis accident. The SCS prevents smoke, hot gases, or fire suppressant agents from migrating to other areas to the extent that they could adversely affect safe-shutdown capabilities including operator action.

The ABVS (described in FSAR Tier 2, Section 9.4.14) is classified as non-safety-related, non-seismic, and not required to operate during a design-basis accident. The ABVS provides conditioned air to all areas of the Access Building and the prestressing gallery underneath the Reactor Building.

ITAAC: Inspections, tests, analyses and acceptance criteria for the CBVS ventilation system are shown in FSAR Tier 1, Table 2.6.8-4, "Containment Building Ventilation System ITAAC." The SBORVS, VRVS, SCS, and ABVS do not contain an ITAAC, as discussed in FSAR Tier 2, Table 14.3.8, (Sheet 4 of 7).

Technical Specifications: There are no Technical Specifications associated with the CBVS, SBORVS, VRVS, SCS or ABVS.

9.4.7.3 *Regulatory Basis*

The relevant requirements of NRC regulations for this area of review, and the associated acceptance criteria, are given in NUREG-0800, Section 9.4.3, "Auxiliary and Radwaste Area Ventilation System," and are summarized below. Review interfaces with other SRP sections can be found in NUREG-0800, Section 9.4.3.

1. GDC 2, as it relates to the system being capable of withstanding the effects of earthquakes.

2. GDC 5, as it relates to shared systems and components important to safety.

3. GDC 60, as it relates to the capability of the system to suitably control release of gaseous radioactive effluents to the environment.

Acceptance criteria adequate to meet the above requirements include:

1. For GDC 2, the systems should meet the guidance of RG 1.29, Regulatory Position C.1, for safety-related portions and Regulatory Position C.2 for non-safety-related portions.

2. For GDC 5, acceptance is based on the determination that sharing of the ventilation system structures systems and components in multiple-unit plants does not significantly

impair their ability to perform their safety functions, including, in the event of an accident in one unit, an orderly shutdown and cooldown of the remaining unit(s).

3. For GDC 60, acceptance is based on the guidance provided in RG 1.52 and RG 1.140 as they relate to the design, inspection, testing, and maintenance criteria for normal atmosphere cleanup systems, ventilation exhaust systems, air filtration and adsorption units of light-water-cooled nuclear power plants.

9.4.7.4 *Technical Evaluation*

Containment Building Ventilation System

Conditioned air is supplied by the NABVS to the Containment Building through the Fuel Building plenum. The containment building ventilation system is divided into four subsystems consisting of the containment purge, internal filtration, containment building cooling, and service compartments cooling.

The containment purge subsystem includes a low-flow purge and full-flow purge supply and exhaust system. The low-flow purge system can operate during normal plant conditions and plant outages. The full-flow purge system operates only during plant outages. The low-flow and full-flow purge systems supply air to the containment building service compartments. The low-flow purge exhaust system outside of containment is designated as a safety-related, Seismic Category 1 ESF ventilation system. The staff's review of ESF filter systems and related regulatory criteria for ESF filter systems is provided in Section 6.5.1 of this report. The low-flow purge exhaust system contains two redundant filtration trains located in the FB consisting of electric heaters, prefilters, HEPA filters, iodine absorbers, and exhaust fans that discharge to the vent stack. Radiation monitors are located upstream of the filtration trains for monitoring the containment exhaust air prior to filtration. The radiation monitor located downstream of the CBVS low flow purge iodine filtration trains monitors and records the release of radioactive contaminants to the vent stack.

The full-flow purge exhaust system discharges to the NABVS.

The internal filtration subsystem recirculates the air within the equipment compartment to reduce the amount of radioactive iodine contamination. The system operates during normal plant conditions and includes a single filtration division. The filtration division consists of an electric heater, prefilter, HEPA filters, iodine absorber, and two redundant fans.

The containment building cooling subsystem contains two divisions with four cooling coils that provide cool air to the reactor coolant pumps, steam generators, CVCS, control rod drive mechanism system (CRDMS), and vent and drain system. In addition, there are two divisions containing cooling fans located in the equipment compartment that provide cool air to the reactor pit during normal plant and station blackout conditions.

The service compartments cooling subsystem consists of 12 recirculating cooling units that provide cool air to the safety injection system valve rooms, steam generator blowdown system tank and heat exchanger rooms, instrument measuring cabinets and table rooms, and containment dome and annular space.

Station Blackout Room Ventilation System

The station blackout room ventilation system provides conditioned air to the station blackout diesel generator Divisions 1 and 2, located inside the Switchgear Building. Each division consists of an independent heating, ventilation, and air conditioning system. The SBORVS is divided into two subsystems for each division consisting of the ventilation of diesel hall and fuel tank room, and ventilation of electrical rooms.

The ventilation of diesel hall and fuel tank room subsystem provides conditioned air to the diesel hall and fuel tank room. The system consists of intake screen and sgrill, supply fans, and electric heaters. The exhaust from the system is discharged to the outside.

The ventilation of electrical room's subsystem provides conditioned air to the electrical rooms. The system draws air from the common supply shared with the diesel hall. The exhaust from the system is recirculated through the HVAC unit.

Main Steam and Feedwater Valve Room Ventilation System

The main steam and feedwater valve room ventilation system provides conditioned air to the valve rooms. The system operates during normal plant and shutdown conditions. The VRVS consists of recirculation ductwork, cooling coils, moisture separators, and recirculation fans. In addition, electric heaters are provided in each valve room to maintain the minimum room temperature during normal operations.

Smoke Confinement System

In the event of a fire, the SCS is initiated either automatically through the plant fire alarm system signal or manually by the fire brigade. The system is designed protect rescue routes between the Main Control Room and the Remote Shutdown Station against inflow of smoke from fire inside the adjacent rooms by supplying fresh outdoor air, pressurizing these areas in relation to adjacent rooms. The SCS consists of a supply and exhaust air subsystem for the interconnecting passageway between Safeguard Building Division 2 and Division 3.

The supply and exhaust air subsystem for the interconnecting passageway between Safeguard Building Division 2 and Division 3 supplies fresh air to the interconnecting passageways for Safeguard Building Division 2 and 3. The system includes fire-resistant concrete air intakes, supply fan, and motor-operated isolation damper. The air from the supply fan is directed through galvanized steel ductwork to the bottom of the escape ladder shaft and to the interconnecting passageway. A pressure control damper and a motor-operated isolation damper installed in the exhaust ductwork provide pressure control in the interconnecting passageway and associated rooms. In case of fire, in these areas, some is extracted through the exhaust ductwork and directed outside the building.

Based on a review of FSAR, Tier 2, Revision 1, Section 9.4.13.2, the staff noted that the pressure control damper and motor-operated isolation damper installed on the exhaust ductwork that provide pressure control in the interconnecting passageways and associated rooms are not shown on the P&ID, Figure 9.4.13-2. Therefore, in RAI 135, Question 09.04.05-1 (Item 9), the staff requested that the applicant provide the location for these dampers on the P&ID.

In a December 17, 2008, response to RAI 135, Question 09.04.05-1 (Item 9), the applicant stated that simplified symbols were used to represent the control dampers and motor-operated dampers on the FSAR figures because of the large variety of components used in the HVAC systems. In addition, the applicant stated that the symbols shown on the HVAC figures (Figure 9.4.13-1, “Typical Configuration of Smoke Confinement System,” and 9.4.13-2) represent the pressure control dampers and motor-operated dampers for the staircase supply air subsystem, supply and exhaust air subsystem for interconnecting passageway between the Safeguard Building Divisions 2 and 3, and the supply and exhaust air subsystem for the Nuclear Island interconnecting passageway. The staff reviewed the response and finds it acceptable because the RAI response clarifies the type of dampers used in the SCS. Additionally, the applicant subsequently changed the design of the SCS significantly in FSAR Tier 2, Revision 2. The applicant’s design changes clarified the staff’s question. Therefore, the staff considers RAI 135, Question 09.04.05-1 (Item 9) resolved.

During review of FSAR Tier 2 revision 2, the staff noted that FSAR Tier 2, Section 9.4.13.2.1 refers to FSAR drawings that have been deleted. The paragraph discusses the SCS Supply and Exhaust Air Subsystem for the Interconnecting Passageway between Safeguards Building Division 2 and Division 3. Therefore, in RAI 461, Question 09.04.01-4, the staff requested that the applicant clarify the paragraph to delete references to deleted drawings and provide drawings or further illustration that clarifies the described arrangement. **RAI 461, Question 09.04.01-4 is being tracked as an open item.**

Access Building Ventilation System

The ABVS provides conditioned air to the Access Building and the prestressing gallery located in the Reactor Building at an elevation of -15.24 m (-50 ft). The ABVS is divided into three subsystems consisting of the supply air, controlled area exhaust air, and supervised area exhaust air.

The supply air subsystem consists of two divisions which provide conditioned air to the Access Building and prestressing gallery underneath the Reactor Building. The system includes air inlets, dampers, heaters, chillers, humidifiers, prefilters, filters, and fans.

The controlled area exhaust air subsystem includes three filtration divisions consisting of prefilters and HEPA filters and two exhaust fans which discharge the exhaust air from the controlled areas to the vent stack.

The supervised area exhaust air subsystem includes two exhaust fans which discharge the exhaust air from the Access Building cold rooms to the atmosphere.

SRP Conformance

The non-safety-related atmospheric cleanup systems were reviewed for conformance to the guidance and acceptance criteria defined in SRP Section 9.4.3. The staff’s review of the ESF filter system requirements for the CBVS as they relate to related ESF filter system GDC (GDC 41, GDC 42, GDC 43, and GDC 61) are reviewed against NUREG-0800, Section 6.5.1 in Section 6.5.1 of this report.

9.4.7.4.1 GDC 2

The guidance for GDC 2 is based on RG 1.29, Regulatory Positions C.1 for safety-related and C.2 for non-safety-related Structures, systems, and components.

CBVS

FSAR Tier 2, Section 9.4.7.1, "Design Bases" identifies some portions of the containment building ventilation system as being safety-related and other portions as non-safety-related. The safety-related portions include the containment penetration isolation valves and low-flow purge filtration system. FSAR Tier 2, Section 9.4.7, Figures 9.4.7-1 through 9.4.7-5 and FSAR Tier 1, Table 2.6.8-1 (Sheet 1) and Table 2.6.8-2, "Containment Building Ventilation System Equipment Mechanical Design," (Sheet 1-2) list the containment penetration isolation valves and low-flow purge filtration components as Seismic I. In addition, the containment isolation valves will automatically close within 5 seconds upon receiving a containment isolation signal. The staff finds that this conforms to RG 1.29, Regulatory Position C.1 Item (o).

The staff finds that FSAR Tier 2, Figures 9.4.7-1 through 9.4.7-5, clearly identifies the breaks between safety-related and non-safety-related portions of the system.

RG 1.29, Regulatory Position C.2 states that those portions of SSCs of which continued function is not required, but of which failure could reduce the functioning of any plant feature identified in RG 1.29, Regulatory Position C.1 to an unacceptable safety level or could result in incapacitating injury to occupants of the control room should be designed and constructed to withstand an SSE.

The staff reviewed FSAR Tier 2, Section 9.4.7.3, "Safety Evaluation" and FSAR Tier 2, Section 15, "Transient and Accident Analysis." With the exception of the containment isolation function, the containment building ventilation system, including the containment low volume purge is not required to operate during a design-basis accident. The divisions between the various seismic classifications were reviewed to determine whether or not the safety-related SSCs' functional integrity would be maintained during a SSE. The P&IDs indicate that the proper divisions between seismic classifications do exist, and there are redundant isolation dampers shown to reduce the effects of a SSE on safety-related SSCs. A failure of the non-safety-related SSCs will not adversely affect any other safety-related system or cause injury to control room personnel; therefore, the staff finds that this meets the requirements of RG 1.29, Regulatory Position C.1.for safety-related portions and RG 1.29, Regulatory Position C.2 for non-safety-related portions of the system. Therefore, the staff finds that the CBVS complies with the requirements of GDC 2.

SBORVS

The staff reviewed the Design Basis section of the FSAR description of the Station Blackout Room Ventilation System in FSAR Tier 2, Section 9.4.10.1 This section describes the components as non-safety-related and non-seismic. Based on the staff's review of the function of the components contained in the station blackout room as described in the FSAR against RG 1.29, Regulatory Position C.2, the staff finds that the designation of the SBORVS as non-safety-related and non-seismic is acceptable because the equipment serviced by the SBORVS functions during beyond design basis events are not required to function after an SSE, and would not cause failure of SSCs that are required to function after an SSC or injury to control room personnel. Therefore, the staff finds that the SBORVS meets the requirements of GDC 2.

VRVS

The staff reviewed the Design Basis section of the FSAR description of the Main Steam and Feedwater Valve Room Ventilation System in FSAR Tier 2, Section 9.4.12.1. This section describes the components as non-safety-related and non-seismic.

However, the staff found that the piping and instrument diagram was inconsistent with the FSAR design basis description for the main steam and feed water valve room ventilation system. FSAR Tier 2, Section 9.4.12.1, "Design Bases," identified the components as NS-AQ and Seismic Category II; whereas, FSAR Tier 2, Figure 9.4.12-1 identified the components as non-seismic. Therefore, in RAI 277, Question 09.04.03-2, the staff requested that the applicant clarify this inconsistency.

RAI 277, Question 09.04.03-2, which is associated with the above request, is being tracked as an open item.

Except for the above RAI and based on a review of the function of the components contained in the station Main Steam and Feedwater Valve room as described in the FSAR against RG 1.29, Regulatory Position C.2, the staff finds that the designation of the VRVS as non-safety-related and non-seismic is acceptable because the VRVS functions are not required to function after a SSE, and would not cause failure of SSCs that are required to function after an SSC or injury to control room personnel. Therefore, the staff finds that the VRVS complies with the requirements of GDC 2.

SCS

The staff reviewed FSAR Tier 2, Section 9.4.13.1, which provides a description of the Smoke Confinement System. This section describes the components as non-safety-related and non-seismic. The staff finds that there are no safety-related components in the Safeguard Building Divisions 2 and 3 interconnected passageway, where the SCS is located. Therefore, the staff finds that the designation of the SCS as non-safety-related and non-seismic is acceptable because the SCS functions are not required to function after a SSE, and would not cause failure of SSCs that are required to function after an SSC or injury to control room personnel. Therefore, the staff finds that the SCS complies with the requirements of GDC 2.

ABVS

The staff reviewed FSAR Tier 2, Section 9.4.14.1, "Access Building Ventilation System –Supply Air Subsystem," which provides a description of the Access Building Ventilation System. This section describes the components as non-safety-related. The staff reviewed FSAR Tier 2, Figure 9.4.14-1, and Figure 9.4.14-2, "Access Building Ventilation System –Supply and Exhaust Air Subsystem." These drawings show all ABVS components as non-seismic. Based on a review of the FSAR, the staff finds that there are no safety-related components in the Access Building, where the ABVS is located. Therefore, the staff finds that the designation of the ABVS as non-safety-related and non-seismic acceptable because the ABVS functions are not required to function after a SSE, and would not cause failure of SSCs that are required to function after an SSC or injury to control room personnel. Therefore, the staff finds that the ABVS complies with the requirements of GDC 2.

Some portions of the containment building ventilation system, smoke confinement system, and access building ventilation system discharge exhaust air to the vent stack. The staff's review of the vent stack for compliance with GDC 2 is discussed in Section 9.4.3 of this report.

9.4.7.4.2 GDC 5

GDC 5 governs the sharing of structures, system, and components important to safety among nuclear power plant units in order to ensure such sharing will not significantly impair their ability to perform their safety functions. Acceptance is based on the determination that the use of the CBVS, SGBVS, VRVS, SCS, and ABVS in multiple-unit plants during an accident in one unit does not significantly affect the capability to conduct a safe and orderly shutdown and cool-down of the remaining unit(s)

The staff reviewed the design of the ventilation systems to ensure that the relevant requirements of GDC 5 are met. The U.S. EPR design is a single-unit station, and the requirements of GDC 5 are not applicable to the single-unit design.

9.4.7.4.3 GDC 60

SCS, SBORVS, and VRVS

Based on the staff's review of the design basis information as stated in the FSAR for these systems, the staff finds that the SCS, SBORVS, and VRVS are not expected to contain or interface with any radioactive materials; they have no normal atmosphere radioactive-contamination clean-up functions; therefore, they are not subject to the requirements of GDC 60 and the guidance of RG 1.140. Based on a review of the layout of the U.S. EPR design, the staff finds that these systems are either located in a separate building from potentially contaminated areas or are not expected to contain or interface with any radioactive materials or both. Therefore, the staff finds these systems are not normal atmosphere cleanup systems which would function to control releases of radioactive materials to the environment, subject to the requirements of GDC 60.

CBVS

The CBVS is located in areas that contain radioactive materials and could release radioactive effluents to the atmosphere; therefore, the CBVS must comply with the requirements of GDC60.

The guidance for GDC 60 is based on RG 1.52 and RG 1.140. RG 1.52 is not applicable to the CBVS, because, as stated in FSAR Tier 2, Section 9.4.7.3, the CBVS is not required to operate in a design basis accident for post-accident ESF atmospheric cleanup.

In RAI 277, Question 09.04.03-3, the staff requested that the applicant clarify the safety-related function of the CBVS in the FSAR and provide additional information on CBVS components in order for the staff to determine if the CBVS design complies with GDC requirements.

In a June 30, 2011, response to RAI 277, Question 09.04.03-3, the applicant provided markups of FSAR Tier 1 and Tier 2 to clarify the safety-related and non-safety-related functions of the CBVS. The staff reviewed the response and the associated markups and determined that more information was required.

In RAI 509, Question 09.04.01-7 the staff requested that the applicant further clarify the role of the CBVS in a design-basis accident and justify why the physical arrangement of the CBVS low volume purge system satisfies single failure criteria if the CBVS low volume purge system is required to function to clean up the postaccident containment atmosphere. **RAI 509, Question 09.04.01-7 is being tracked as an open item.**

RG 1.140, Regulatory Positions C.2 and C.3 provide the environmental and design criteria guidance for normal atmosphere cleanup systems.

RG 1.140, Regulatory Position C.2

The design of a normal atmosphere cleanup system should be based on the anticipated operating ranges for temperature, pressure, relative humidity, and radiation levels during normal plant operations and anticipated operational occurrences per RG 1.140, Regulatory Position C.2.1. While the applicant has only provided information on the operating ranges for temperature and relative humidity associated with normal plant operation for the containment building ventilation system, as stated in FSAR Tier 2, Section 9.4.7.1, the commitment made to both RG 1.140 and ASME AG-1 provides assurance that the design considers both pressures and radiation levels for normal plant operations and anticipated operational occurrences. Therefore, the staff finds that the CBVS conforms to RG 1.140, Regulatory Position C.2.1.

If the normal atmosphere cleanup system is located in an area with high radiation during normal plant operation, then adequate shielding of components and personnel from the radiation source should be provided per RG 1.140, Regulatory Position C.2.2. The Containment Building is subdivided into two compartments, which consist of an inner equipment compartment and an outer service compartment. The inner equipment compartment contains high radiation sources, such as the steam generators, reactor coolant pumps, and primary loop piping. The outer service compartment contains support equipment. Based on a review of FSAR Tier 2, Section 12.3.1.1, “Reactor Building,” the staff finds that shielding is provided within rooms and compartments to protect equipment and components from each other. In addition, the shielding allows personnel to access the service compartments during outages. Therefore, the staff finds that this conforms to RG 1.140, Regulatory Position C.2.2.

The operation of any normal atmosphere cleanup system should not degrade the expected operation of any ESF system that is required to operate after a design-basis accident per RG 1.140, Regulatory Position C.2.3. The staff finds that this requirement is not applicable to the containment building ventilation system, because as stated in FSAR Tier 2, Section 9.4.7.3, the CBVS low volume purge exhaust path is isolated on receipt of a containment isolation signal and is not credited to perform any post-accident ESF function and, therefore, not required to operate after a design basis accident.

The design of a normal atmosphere cleanup system should consider any significant contaminants such as dust, chemicals, excessive moisture, or other particulate matter that could degrade the cleanup system’s operation per RG 1.140, Regulatory Position C.2.4. Materials of construction and components shall be selected and tested to limit the generation of combustibles and contaminants per ASME N509, Section 4.4, and various ASME AG-1 sections. Based on the staff’s review of FSAR Tier 2, the staff determined that more information was required to make a finding in this area. Therefore, in RAI 135, Question 09.04.05-1 (Item 8), the staff requested that the applicant provide evidence on the use of gaskets, seals, or other protective devices for the purpose of minimizing contaminant leakage into the containment building ventilation system to conform to RG 1.140, Regulatory Position C.2.4.

In a December 17, 2008, response to RAI 135, Question 09.04.05-1 (Item 8), the applicant stated that the internal filtration cleanup system and components are designed in accordance with ASME AG-1 for leak tightness and will be leak tested to the requirements of ASME/ANSI N510. The staff reviewed the response and finds that it acceptable. Therefore, the staff finds that the CBVS conforms to RG 1.140, Regulatory Position C.2.4 based on conformance with applicable industry standards. Therefore, the staff considers RAI 135, Question 09.04.05-1 (Item 8) as it applies to leak tightness of cleanup system components resolved.

RG 1.140, Regulatory Position C.3

RG 1.140, Regulatory Position C.3.1 states that a normal atmosphere cleanup system need not be redundant nor designed to Seismic Category I classification. But at a minimum, a system should consist of the following components in the specified order:

- HEPA filters before the adsorbers
- Iodine adsorbers (impregnated activated carbon)
- Fans
- Interspersed ducts, dampers, and related instrumentation

RG 1.140 recommends that prefilters be installed upstream of the HEPA filters to increase the HEPA filters' service life. Also, it is recommended to install HEPA filters downstream of carbon adsorbers to retain carbon fines.

It is not required to include an iodine adsorption component if the atmosphere cleanup system removes only particulate matter.

The staff's review of the P&IDs for the containment building ventilation system demonstrates that the CBVS conforms to RG 1.1.40, Regulatory Position C.3.1. In addition, as shown in FSAR Tier 2, Figure 9.4.7-2, the CBVS provides redundant ventilation divisions for handling operational occurrences, even though the guidance in RG 1.140, Regulatory Position C.3.1 does not call for redundant divisions.

To ensure reliable in-place testing, the volumetric air-flow rate of a single cleanup unit should be limited to approximately 849.51 m^3/min (30,000 cfm). If a total system air flow in excess of this rate is required, multiple units should be used per RG 1.140, Regulatory Position C.3.2. Based on the staff's review of FSAR Tier 2, the staff determined that more information was required to make a finding in this area. Therefore, in RAI 135, Question 09.04.05-1 (Item 8), the staff requested that the applicant provide data on the air-flow rates for the containment building ventilation system cleanup units to conform to RG 1.140, Regulatory Position C.3.2.

In a December 17, 2008, response to RAI 135, Question 09.04.05-1 (Item 8), the applicant stated that the containment building low flow purge subsystem is safety-related and is designed to meet RG 1.52. In addition, the applicant indicated that the engineered safety feature filter system for the low flow purge system is designed with a nominal flow rate of 84.95 m^3/min (3,000 cfm). The staff reviewed that the applicant's response concluded that the response only provided flow rates for the CBVS low flow purge filters. Therefore, in RAI 277, Question 09.04.03-1, the staff requested that the applicant address the air-flow rates for all subsystems that comprise the containment building ventilation system as previously requested in RAI 135, Question 09.04.05-1 (Item 8).

In a July 28, 2010, response to RAI 277, Question 09.04.03-1, the applicant stated that the internal filtration subsystem has a nominal flow rate of 117 m^3/min (4,120 cfm).which conforms to RG 1.140, Regulatory Position C.3.2. The applicant clarified that the containment building cooling subsystem and the service compartments cooling subsystems are air cooling systems and do not include cleanup units; therefore, RG 1.140, Regulatory Position C.3.6 do not apply to these subsystems, but comply to applicable portions of ASME AG-1.

Based on the information in the FSAR and as clarified by response to RAI 277, Question 09.04.03-1 the staff finds that the CBVS conforms to RG 1.140, Regulatory Position C.3.2, and therefore the staff considers RAI 277, Question 09.04.03-1 resolved.

Each normal atmosphere cleanup system should be instrumented to monitor and alarm for pertinent pressure drops and flow rates per RG 1.140, Regulatory Position C.3.3. Based on a review of FSAR Tier 2, Figure 9.4.7-1, P&IDs for the containment building ventilation system, which shows instrumentation measuring air flow rates and differential pressure across filters, adsorbers, and fans, the staff finds that the CBVS conforms to RG 1.140, Regulatory Position C.3.3

To maintain the radiation exposure to operating and maintenance personnel ALARA, normal atmosphere cleanup systems and components should be designed to control leakage and facilitate maintenance, inspection, and testing per RG 1.140, Regulatory Position C.3.4. Therefore, in RAI 135, Question 09.04.05-1 (Item 8), the staff requested that the applicant provide information to conform to RG 1.140, Regulatory Position C.3.4.

The applicant's December 17, 2008, response to RAI 135, Question 09.04.05-1 (Item 8), did not include details on design features which help reduce personnel radiation exposure sufficient for the staff to determine if the design adequately addressed RG 1.140, Regulatory Position C.3.4. However, the applicant's February 27, 2009, response to RAI 135, Question 09.04.05-1 (Item 7), stated that RG 1.140, Regulatory Position C.3.4 is addressed in FSAR Tier 2, Sections 12.3.1.9.2 and 12.3.3.3. FSAR Tier 2, Section 12.3.1.9.2 addresses common equipment installed within the U.S. EPR that provides features which help reduce personnel radiation exposure. The staff reviewed FSAR Tier 2, Section 12.3.1.9.2 and finds that this section provides evidence that HEPA filters are used for various U.S. EPR ventilation systems to minimize dose resulting from service, testing, inspection, decontamination, and component replacement.

The staff reviewed FSAR Tier 2, Section 12.3.3.3 and finds that this section provides information on the protective design features implemented in the U.S. EPR to minimize radiation exposure. These features include the following:

- Air flow direction is from low radioactivity to higher radioactivity.
- Rooms or spaces potentially contaminated are maintained at a negative pressure to minimize airborne radioactivity.
- The main control room is maintained at a positive pressure to keep out airborne radioactivity.
- Ventilated air is only recirculated in clean areas.
- Ventilation air is released to the environment after it is processed, by removing airborne radioactive iodine and particulates.
- Containment isolation valves are installed in accordance with 10 CFR 50, Appendix A, in order to maintain the containment integrity.

- The Nuclear Island drain and vent systems are connected directly to the ventilation system rather than being vented to containment spaces.

- HVAC system components are located in areas with low radiation to minimize personnel exposure during maintenance, inspection, and testing.

- Maintenance of carbon filters is handled by automated equipment.

- The U.S. EPR air cleaning systems are designed, maintained, and tested in accordance with RG 1.52 for post-accident engineered safety feature atmospheric cleanup system and RG 1.140 for normal atmospheric cleanup system.

The staff reviewed FSAR Tier 2, Sections 12.3.1.9.2 and 12.3.3.3 and finds the information in them sufficient to find that the CBVS conforms to RG 1.140, Regulatory Position C.3.4. Therefore, the staff considers RAI 135, Question 09.04.05-1 (Item 8), related to RG 1.140, Regulatory Position C.3.4 resolved.

Outdoor air intake openings should be equipped with louvers, grills, screens, or similar protective devices to minimize the effects of high winds, rain, snow, ice, trash, and other contaminants on the operation of the system per RG 1.140, Regulatory Position C.3.5. The containment building ventilation system does not receive its supply air from outdoor air intakes; therefore, RG 1.140, Regulatory Position C.3.5 is not applicable to the CBVS.

Normal atmosphere cleanup system housings and ductwork are designed to exhibit, on test, a maximum total leakage rate as defined in Article SA-4500 of ASME AG-1-1997 Ref. 3. Based on the staff's review of FSAR Tier 2, the staff determined that more information was required to make a finding in this area. Therefore, in RAI 135, Question 09.04.05-1, the staff requested that the applicant provide the leakage rates for the containment building ventilation system to conform to RG 1.140, Regulatory Position C.3.6.

In a December 17, 2008, response to RAI 135, Question 09.04.05-1 (Item 8), the applicant stated that the internal filtration cleanup system and components are designed in accordance with ASME AG-1 for leak tightness and will be leak tested to the requirements of ASME/ANSI N510. The staff reviewed FSAR Tier 2, Section 9.4.7.2.1, "General Description," and only found reference to the containment purge subsystem being designed in accordance with ASME AG-1-2003. Therefore, in RAI 277, Question 09.04.03-1, the staff requested that the applicant address the maximum total leakage rate as defined in Article SA-4500 of ASME AG-1-1997 for all subsystems that comprise the containment building ventilation system, as previously requested in RAI 135, Question 09.04.05-1 (Item 8).

In a July 28, 2010, response to RAI 277, Question 09.04.03-1, the applicant reiterated that the CBVS conforms to RG 1.140 with the exception that it complies with applicable portions of ASME AG-1-2003. The staff reviewed the response and determined that additional detail is required in the FSAR in order to provide assurance that startup testing of the system will include a leak test. Therefore, the staff issued follow-up RAI 4561, Question 09.04.03-5, the staff requested that the applicant clarify the testing requirements for the NABVS and the RWBVS as they relate to guidance contained in RG 1.140, Regulatory Position C.3.6, which states:

> Normal atmosphere cleanup system housings and ductwork should be designed to exhibit, on test, a maximum total leakage rate as defined in Article SA-4500 of ASME AG-1-1997 (Ref. 3). Duct and housing leak tests should be performed in accordance with Section TA of ASME AG-1-1997.

RAI 461, Question 09.04.03-5, which is associated with the above request, is being tracked as an open item.

Except for the open item discussed above, based on information in the FSAR the staff finds that the CBVS conforms to RG 1.140, Regulatory Position C.3.6. Accordingly, based on the above, the staff finds that the design, inspection and testing of the CBVS conform to RG 1.140, Regulatory Positions C.2 and C.3 and, therefore, complies with the requirements of GDC 60.

ABVS

The ABVS service controlled areas of the Access Building which could contain radioactive materials and therefore the controlled area exhaust subsystem of the ABVS could release radioactive effluents to the atmosphere; therefore, this portion of the ABVS must comply with the requirements of GDC 60.

The guidance for GDC 60 is based on RG 1.52 and RG 1.140. RG1.52 is not applicable to the ABVS, because, as stated in FSAR Tier 2, Section 9.4.14.1, the ABVS is not required to operate during a design basis accident.

Therefore the staff finds that RG 1.140, Regulatory Position C.2 and C.3, which provides the environmental and design criteria guidance for normal atmosphere cleanup systems is applicable to the ABVS.

FSAR Tier 2, Section 9.4.14 and FSAR Tier 2, Figure 9.4.14-2 describe the Access Building Ventilation System as servicing an Access Building that is divided into a radiological controlled area, which presumably has the potential to become contaminated. Both the controlled area of this building and the supervised (clean) area are serviced by the ABVS. The ABVS as shown in the FSAR has two different exhaust subsystems. The subsystem that services the controlled areas exhausts through HEPA filters and is monitored for radioactivity. The exhaust subsystem that services the supervised area releases directly to the environment with no devices to filter radioactivity or monitor for radioactivity. Based on the review of this system, in RAI 461, Question 09.04.03-6, the staff requested that the applicant provide details of the access building and the ABVS to justify why the Superivised area of the Access Building is not subject to GDC 60. **RAI 461, Question 09.04.03-6 which is associated with the above request, is being tracked as an open item**

RG 1.140, Regulatory Position C.2

The design of a normal atmosphere cleanup system should be based on the anticipated operating ranges for temperature, pressure, relative humidity, and radiation levels during normal plant operations and anticipated operational occurrences per RG 1.140, Regulatory Position C.2.1. While the applicant did not provide information on the operating ranges for temperature and relative humidity associated with normal plant operation for the access building ventilation system, FSAR Tier 2, Section 9.4.14.4 states that the controlled area exhaust system of the ABVS is designed, installed and tested in accordance with RG 1.143, RG1.140, ASME N509, ASME N510, and ASME AG-1. The staff finds that the commitment made to both RG 1.140 and ASME AG-1 provides assurance that the design considers both pressures and radiation levels for normal plant operations and anticipated operational occurrences. Therefore, the staff finds that the ABVS conforms to RG 1.140, Regulatory Position C.2.1.

If the normal atmosphere cleanup system is located in an area with high radiation during normal plant operation, then adequate shielding of components and personnel from the radiation source should be provided per RG 1.140, Regulatory Position C.2.2. The staff finds that the Access building is located outside containment, in a low radiation area. Therefore the staff finds that RG 1.140, Regulatory Position C.2.2 is not applicable to the ABVS.

The operation of any normal atmosphere cleanup system should not degrade the expected operation of any ESF system that is required to operate after a design-basis accident per RG 1.140, Regulatory Position C.2.3. The staff finds that this requirement is not applicable to the ABVS, because as stated in FSAR Tier 2, Section 9.4.14.1, the ABVS does not perform any ESF function and therefore not required to operate after a design basis accident.

The design of a normal atmosphere cleanup system should consider any significant contaminants such as dust, chemicals, excessive moisture, or other particulate matter that could degrade the cleanup system's operation per RG 1.140, Regulatory Position C.2.4. Materials of construction and components shall be selected and tested to limit the generation of combustibles and contaminants per ASME N509, Section 4.4, and various ASME AG-1 sections. FSAR Tier 2, Section 9.4.14.4 states that the controlled area exhaust system of the ABVS is designed, installed and tested in accordance with RG 1.143, RG1.140, ASME N509, ASME N510, and ASME AG-1. The staff finds that the commitment made to these standards conform to RG 1.140, Regulatory Position C.2.4.

RG 1.140, Regulatory Position C.3

RG 1.140, Regulatory Position C.3.1 states that a normal atmosphere cleanup system need not be redundant nor designed to Seismic Category I classification. But at a minimum, a system should consist of the following components in the specified order:

- HEPA filters before the adsorbers
- Iodine adsorbers (impregnated activated carbon)
- Fans
- Interspersed ducts, dampers, and related instrumentation

RG 1.140 recommends that prefilters be installed upstream of the HEPA filters to increase the HEPA filters' service life. Also, it is recommended to install HEPA filters downstream of carbon adsorbers to retain carbon fines.

It is not required to include an iodine adsorption component if the atmosphere cleanup system removes only particulate matter.

The staff reviewed the P&IDs for the ABVS system. The staff finds that the system arrangement on FSAR Tier 2, Figure 9.14.-2 demonstrates that the ABVS conforms to RG 1.1.40, Regulatory Position C.3.1. The staff notes that the design of the ABVS controlled area exhaust subsystem does not include iodine absorption, which meets the system criteria in RG 1.1.40, Regulatory Position C.3.1 for those systems designed to remove only particulate matter.

To ensure reliable in-place testing, the volumetric air-flow rate of a single cleanup unit should be limited to approximately 849.51 m^3/min (30,000 cfm). If a total system air flow in excess of this rate is required, multiple units should be used per RG 1.140, Regulatory Position C.3.2. FSAR Tier 2, Section 9.4.14.4 states that the controlled area exhaust system of the ABVS is designed, installed and tested in accordance with RG 1.143, RG1.140, ASME N509, ASME N510, and ASME AG-1. The staff finds that the commitment made to both RG 1.140 and ASME AG-1 provides assurance that the design considers the 849.51 m^3/min (30,000 cfm) flowrate limit for a single clean up unit and therefore the staff finds that the air-flow rates for the ABVS system cleanup units conform to RG 1.140, Regulatory Position C.3.2.

Each normal atmosphere cleanup system should be instrumented to monitor and alarm for pertinent pressure drops and flow rates per RG 1.140, Regulatory Position C.3.3. Based on review of FSAR Tier 2, Figure 9.4.14-2, P&ID for the ABVS, which shows instrumentation measuring air flow rates and differential pressure across filters, and fans; the staff finds that, the ABVS conforms to RG 1.140, Regulatory Position C.3.3.

To maintain the radiation exposure to operating and maintenance personnel ALARA, normal atmosphere cleanup systems and components should be designed to control leakage and facilitate maintenance, inspection, and testing per RG 1.140, Regulatory Position C.3.4.

The staff reviewed FSAR Tier 2, Sections 12.3.1.9.2 and 12.3.3.3. FSAR Tier 2, Section 12.3.1.9.2 addresses common equipment installed within the U.S.EPR that provides features which help reduce personnel radiation exposure. The staff reviewed FSAR Tier 2, Section 12.3.1.9.2 and finds that this section provides evidence that HEPA filters are used for various U.S. EPR ventilation systems to minimize dose resulting from service, testing, inspection, decontamination, and component replacement.

The staff reviewed FSAR Tier 2, Section 12.3.3.3 and finds that this section provides information on the protective design features implemented in the U.S. EPR to minimize radiation exposure. These features include the following:

- Air flow direction is from low radioactivity to higher radioactivity.
- Rooms or spaces potentially contaminated are maintained at a negative pressure to minimize airborne radioactivity.
- The main control room is maintained at a positive pressure to keep out airborne radioactivity.
- Ventilated air is only recirculated in clean areas.
- Ventilation air is released to the environment after it is processed, by removing airborne radioactive iodine and particulates.
- Containment isolation valves are installed in accordance with 10 CFR 50, Appendix A, in order to maintain the containment integrity.
- The Nuclear Island drain and vent systems are connected directly to the ventilation system rather than being vented to containment spaces.
- HVAC system components are located in areas with low radiation to minimize personnel exposure during maintenance, inspection, and testing.
- Maintenance of carbon filters is handled by automated equipment.

- The U.S. EPR air cleaning systems are designed, maintained, and tested in accordance with RG 1.52 for post-accident engineered safety feature atmospheric cleanup system and RG 1.140 for normal atmospheric cleanup system.

The staff reviewed FSAR Tier 2, Sections 12.3.1.9.2 and 12.3.3.3 and found the information in them sufficient to find that the ABVS conforms to RG 1.140, Regulatory Position C.3.4.

Outdoor air intake openings should be equipped with louvers, grills, screens, or similar protective devices to minimize the effects of high winds, rain, snow, ice, trash, and other contaminants on the operation of the system per RG 1.140, Regulatory Position C.3.5. FSAR Tier 2, Section 9.4.14.4 states that the controlled area exhaust system of the ABVS is designed, installed and tested in accordance with RG 1.143, RG1.140, ASME N509, ASME N510, and ASME AG-1. The staff finds that the commitment made to both RG 1.140 and ASME AG-1 provides assurance that the design of outdoor air intake openings will be equipped with louvers, grills, screens, or similar protective devices to minimize the effects of high winds, rain, snow, ice, trash, and other contaminants. Therefore, the staff finds that the ABVS conforms to RG 1.140, Regulatory Position C.3.5.

Normal atmosphere cleanup system housings and ductwork are designed to exhibit, on test, a maximum total leakage rate as defined in Article SA-4500 of ASME AG-1-1997 Ref. 3. FSAR Tier 2, Section 9.4.14.4 states that the controlled area exhaust system of the ABVS is designed, installed and tested in accordance with RG 1.143, RG1.140, ASME N509, ASME N510, and ASME AG-1. The staff finds that the commitment made to both RG 1.140 and ASME AG-1 provides assurance that the ABVS preoperational testing conforms to RG 1.140, Regulatory Position C.3.6.

Based on the above, the staff finds that the design, inspection and testing of the ABVS conform to RG 1.140, Regulatory Positions C.2 and C.3 and, therefore complies with the requirements of GDC 60.

FSAR Tier 1 Information

The staff reviewed the tier 1 information for the CBVS and its associated safety-related features and functions. The CBVS description in Tier 1, Section 2.6.8 and the Tier 1 information description in FSAR Tier 2, Section 14.3 were also reviewed. The staff finds that sufficient information has been provided to satisfy SRP Section 14.3 and SRP 14.3.7 for the CBVS. The staff finds that FSAR Tier 1 information is not required for the SBORVS, VRVS, SCS, and ABVS.

ITAAC

The staff reviewed the proposed ITAAC for the CBVS and its associated safety-related features. The applicant’s proposed ITAAC requirements in FSAR Tier 1, Tables 2.6.8-4, and FSAR Tier 2, Section 14.3 were reviewed. The staff finds that sufficient information has been provided to satisfy SRP Section 14.3 and SRP 14.3.7.

The staff finds that the ITAAC information provided for the CBVS adequately covered the safety-related components. ITAAC information is not required for the SBORVS, VRVS, SCS, and ABVS. Therefore, the staff finds the ITAAC requirements for the SBORVS, VRVS, and ABVS acceptable in meeting the requirements of 10 CFR 52.47(b) (1).

Technical Specifications

There are no Technical Specifications associated with CBVS, SBORVS, VRVS and the ABVS. Safety-related atmospheric cleanup functions are controlled by the SBVS technical specifications. The staff finds that this complies with NUREG-0800, Section 16 and NUREG-1431, “Standard Technical Specifications (STS) for Westinghouse Plants,” for the CBVS, SBORVS, VRVS, and the ABVS, and is therefore acceptable.

Initial Testing Requirements

The initial plant startup testing for the CBVS, SBORVS, VRVS, SCS, and ABVS defined in FSAR Tier 2, Section 14.2. The following tests identified for each system are given below:

1. Containment Building Ventilation System

   Test Nos. 073, 075, 076, and 203

2. Station Blackout Room Ventilation System

   Test No. 086

3. Main Steam and Feedwater Valve Room Ventilation System

   Test No. 087

4. Smoke Confinement System

   Test No. 085

5. Access Building Ventilation System

   Test No. 224

The staff finds that the tests for each system adequately cover the pre-startup requirements for each atmospheric cleanup system.

9.4.7.5 *Combined License Information Items*

There are no COL information items related to this area of review. The staff finds that there are no additional items needed for this area of review.

9.4.7.6 *Conclusions*

The staff reviewed the CBVS, SBORVS, VRVS, SCS, and ABVS using acceptance criteria defined in NUREG-0800, Section 9.4.3

Except for the open item related to RAI 277, Question 09.04.03-2 for the VRVS, the staff concludes that the design of these systems presented in FSAR Tier 1, Section 2.6.8 and FSAR Tier 2, Revision 2, Sections 9.4.7, 9.4.10, 9.4.12, 9.4.13, and 9.4.14, complies with the requirements of GDC 2. Since the U.S. EPR design is a single unit, GDC 5 is not applicable. The staff finds that SBORVS, SCS, and VRVS do not function as normal atmosphere cleanup systems; therefore, GDC 60 does not apply to these systems. Except for the open items related to RAI 461, Question 09.04.03-5, RAI 461, Question 09.04.03-6, and RAI 509, Question 09.04.01-7, the staff finds that the CBVS and the ABVS comply with the requirements of GDC 60. The ITAAC requirements will ensure that the CBVS can be properly inspected, tested, and operated in accordance with the design basis as described in the FSAR requirements and, therefore, complies with10 CFR 52.47(b)(1).

9.4.8 Radioactive Waste Building Ventilation System

The staff has performed its review of the RWBVS in Section 9.4.3 of this report.

9.4.9 Emergency Power Generating Building Ventilation System

The staff has performed its review of the EPGBVS in Section 9.4.5 of this report.

9.4.10 Switchgear Building Ventilation System

The staff has performed its review of the SBORVS in Section 9.4.7 of this report.

9.4.11 Essential Service Water Pump Building Ventilation System

The staff has performed its review of the ESWPBVS in Section 9.4.5 of this report.

9.4.12 Main Steam and Feedwater Valve Room Ventilation System

The staff has performed its review of the VRVS in Section 9.4.7 of this report.

9.4.13 Smoke Confinement System

The staff has performed its review of the SCS in Section 9.4.7 of this report.

9.4.14 Access Building Ventilation System

The staff has performed its review of the ABVS in Section 9.4.7 of this report.

9.5 Other Auxiliary Systems

Other auxiliary systems are discussed in Final Safety Analysis Report (FSAR) Tier 2, Section 9.5. Diesel generator auxiliary systems are included in this section. Diesel generator auxiliaries include the fuel oil storage and transfer system (Section 9.5.4), cooling water system (Section 9.5.5), starting air system (Section 9.5.6), lubricating system (Section 9.5.7), and air intake and exhaust system (Section 9.5.8).

9.5.1 Fire Protection Program

9.5.1.1 *Introduction*

The EPR fire protection program (FPP) provides assurance, through a defense-in-depth philosophy, that the Commission’s fire protection objectives are satisfied. These objectives are: (1) To prevent fires from starting; (2) to detect rapidly, control, and extinguish promptly those fires that do occur; and (3) to provide protection for structures, systems, and components important to safety so that a fire that is not promptly extinguished by the fire suppression activities will not prevent the safe-shutdown of the plant.

9.5.1.2 *Summary of Application*

FSAR Tier 1: The FSAR Tier 1 information associated with this section is found primarily in FSAR Tier 1, Sections 2.1.1.1, "Reactor Building (RB)"; 2.1.1.2, "Safeguard Buildings (SB)"; 2.1.1.3, "Fuel Building (FB)"; 2.1.2, "Emergency Power Generating Buildings (EPGB)"; 2.1.5, "Essential Service Water Building (ESWB)"; 2.2.1, "Reactor Coolant System"; 2.4.2, "Safety Information and Control System"; 2.4.6, "Plant Fire Alarm System (PFAS)"; 2.4.10, "Process Information and Control System"; 2.4.21, "Communication System"; 2.5.9, "Lighting System"; 2.6.11, "Smoke Confinement System"; 2.7.3, "Sprinkler System"; 2.7.5, "Fire Water Distribution System (FWDS)"; 2.7.6, "Gaseous Fire Extinguishing System (GFES)"; Sections 4.2, "Fire Protection Storage Tanks and Building"; and 4.8, "Fire Water Distribution System." The non-safety-related PFAS provides a fire alarm system interface for plant operators; monitors and controls fire detection and suppression equipment; and provide alarms, indications, and controls of manual and automatic fire protection equipment in the main control room and at the remote shutdown station. The PFAS has both a normal and an automatic backup power supply. The FWDS provides a safety-related function to isolate the Reactor Building upon receipt of a containment isolation signal. Non-safety-related functions of the FWDS include providing an alternate source of makeup water from the seismically qualified portion of the FWDS to the component cooling water system surge tank. The system is made up of two separate fresh water storage tanks and at least one motor-driven and one diesel-driven fire water pump. The FWDS piping allows for flow testing of the fire water pumps during normal operation. The FWDS standpipe and hose systems in areas containing systems and components credited for safe plant shutdown in the event of a safe shutdown earthquake (SSE), including the water supply to these standpipes, are capable of remaining functional and supplying two hose stations following an SSE. The raw water supply system provides makeup water to the fire water storage tanks. Detailed FSAR Tier 1 mechanical, electrical, and instrumentation information associated with the FWDS design is specified in FSAR Tier 1, Tables 2.7.5-1, "Fire Water Distribution System Equipment Mechanical Design," and 2.7.5-2, "Fire Water Distribution System Equipment I&C and Electrical Design." The non-safety-related GFES is a total flooding, gaseous fire suppression system for the MCR sub-floor area enclosure. The COL applicant will provide the design of the fire protection storage tanks and building. This building will house portions of the fire protection system and fire pumps with the storage tanks in close proximity to the pump building.

FSAR Tier 2: This section of the report includes a summary, in part, of the key U.S. EPR fire protection design commitments by AREVA that are set forth in FSAR Tier 2, Revision 2, Section 9.5.1 and Appendix 9A. Section 9.5.1.4 of this report provides the staff's technical evaluation of the design.

The purpose of the FPP is to protect plant systems and equipment which provide the capability to safely shut down the reactor, maintain it in a safe shutdown condition, control radioactive releases to the environment, and prevent personnel injury and property damage in the event of a fire.

The FPP consists of fire protection system (FPS) design features, personnel, equipment, and procedures to provide defense-in-depth protection of public health and safety in accordance with Standard Review Plan (SRP) Section 9.5.1 and Regulatory Guide (RG) 1.189. The program is implemented during station operations by the prevention, detection, annunciation, confinement, and extinguishment of fire. Administrative controls, training, inspection, testing, and quality assurance (QA) provide reasonable assurance of the feasibility and reliability of the program.

The primary objective of the FPP is to minimize the probability and consequences of postulated fires. The program credits passive and active fire protection features to ensure that the SSCs necessary to achieve and maintain safe plant shutdown, with or without offsite power, remains available.

Additionally, an FPP objective is to minimize the potential for fire events to impact safety functions such as reactivity control, decay heat removal, and spent fuel pool cooling or result in the release of radioactive materials during non-power modes. Implementation of the site-specific FPP described, in part, herein will be in accordance with RG 1.189, Regulatory Position C.1 and is the responsibility of the COL applicant as discussed in FSAR Tier 2, Revision 2, Section 13.4.

The FPP organization structure and the responsibilities for its establishment and implementation are in accordance with RG 1.189. The COL applicant is responsible for determining the individual position responsible for the organizational functions described herein as discussed in FSAR Tier 2, Revision 2, Section 13.1).

The FPS detects fires and provides fire extinguishment capability using fixed automatic and manual suppression systems, manual hose streams, and portable fire fighting equipment. In addition, FPS must be designed such that their failure or inadvertent operation does not adversely impact the ability of the structures, systems, and components important to safety to perform their safety functions.

The FPS is classified as non-safety related. Non-safety-related functions of the FWDS include providing an alternate source of makeup water from the seismically qualified portion of the FWDS to the component cooling water system surge tanks. The fire protection containment isolation valves and associated piping are classified as safety-related functions and are designed as Seismic Category I per RG 1.29, Regulatory Position C.1.o. The FPS portion of the containment isolation system meets the containment isolation requirements of GDC 56. The FPS water supply storage tanks, pumps, and portions of the distribution piping that provide fire protection flow to standpipes located in areas containing Seismic Category I equipment are designed to withstand seismic events per RG 1.29, Regulatory Position C.2 and must remain functional after an SSE event.

The portions of the FPS that provide containment isolation or water to the standpipes that protect those areas of the plant containing Seismic Category I equipment used for safe plant shutdown are required to remain functional during and following seismic events up to a safe shutdown earthquake. Other portions of the FPS are not required to remain functional following a safe shutdown earthquake.

The fire protection analysis ((FSAR Tier 2, Revision 2, Appendix 9A) evaluates the adequacy of fire protection for systems and plant areas.

Technical Specifications: The Technical Specifications associated with FSAR Tier 2, Revision 2, Section 9.5.1 are given in FSAR Tier 2, Revision 2, Chapter 16, Section 5.4.1. This section requires that written procedures be established, implemented, and maintained covering Fire Protection Program implementation.

U.S. EPR Plant Interfaces: This section of the FSAR contains information related to the following plant interfaces that will be addressed in the COL designs: Fire Protection Storage Tanks and Building (FSAR Tier 1, Section 4.2 and FSAR Tier 2, Table 1.8-1, Item No. 1-4); Fire water Distribution System (FSAR Tier 1, Sections 4.8 and 2.7.5 and FSAR Tier 2, Table 1.8-1, Item .9-4.

9.5.1.3 *Regulatory Basis*

The staff reviewed FSAR Tier 1, Revision 2, Sections 2.1, 2.2, 2.4, 2.5, 2.6, 2.7, 4.2, 4.8, and FSAR Tier 2, Section 9.5.1, "Fire Protection System," in accordance with NUREG-0800, Revision 5, Section 9.5.1, "Fire Protection Program". The applicant's FPP is acceptable if it meets the applicable regulatory requirements. These requirements and the regulatory guidance for meeting them are as follows:

1. 10 CFR 50.48(a) requires that the holders of a combined license issued under 10 CFR Part 52 have a fire protection plan that meets General Design Criteria (GDC) 3, "Fire Protection," in Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities"; that the plan describe specific features necessary to its implementation; and that the licensee retain the plan and all changes to it as records until the Commission terminates the reactor license.

2. Under 10 CFR 52.47(a)(9) the application must include an evaluation of the facility against the SRP revision in effect 6 months before the docket date of the application.

3. GDC 3 as it relates to the requirement for the following:

    - SSCs important to safety be designed and located to minimize, consistent with other safety requirements, the probability and effect of fires and explosions.

    - Noncombustible and heat resistant materials be used wherever practical throughout the unit.

    - Fire detection and fighting systems of appropriate capacity and capability be provided and designed to minimize the adverse effects of fires on SSCs important to safety.

    - Fire fighting systems be designed to assure that their rupture or inadvertent operation does not significantly impair the safety capability of these SSCs.

4. GDC 19 as it relates to the requirement for the plant design to include a control room that allows plant operators to maintain the plant in a safe condition under normal and accident conditions and to make equipment available at alternate locations outside the control room to achieve and maintain hot shutdown with the potential capability for subsequent cold shutdown of the reactor.

5. GDC 23, "Protection System Failure Modes," as it relates to the requirement that the reactor protection system be designed to fail in a safe state if postulated adverse environments occur, including extreme heat, fire and water discharged from fire suppression systems.

6. 10 CFR 52.47(b)(I), as it relates to the requirement that an application for design certification contain proposed inspections, tests, analysis, and acceptance criteria (ITAAC) which are necessary and sufficient to provide reasonable assurance that, if performed and acceptance criteria are met, a plant that references the design is built and will operate in accordance with the design certification.

7. 10 CFR 52.48, “Standards for Review of Applications,” as it relates to the requirement that the application for a certified design be reviewed for compliance with the standards set out in 10 CFR Part 20, 10 CFR Part 50 and Appendices, 51, 73, and 100.

Acceptance criteria adequate to meet the above requirements include:

1. SRP Section 9.5.1, Revision 5, “Fire Protection Program,” contains guidance and acceptance criteria for an FPP that meets the regulatory requirements described above.

2. RG 1.189, Revision 1, “Fire Protection for Nuclear Power Plants,” provides guidance and acceptance criteria for one acceptable approach for an FPP that meets the regulatory requirements described above.

3. In addition, SRP Section 9.5.1 provides enhanced fire protection criteria for new reactor designs as documented in SECY 90-016, “Evolutionary Light Water Reactor (LWR) Certification Issues and Their Relationship to Current Regulatory Requirements,” January 12, 1990, and as documented in SECY 93-087, “Policy, Technical, and Licensing Issues Pertaining to Evolutionary and Advanced Light-Water Reactor (ALWR) Designs,” April 2, 1993.

9.5.1.4 *Technical Evaluation*

The staff reviewed FSAR Tier 1, Revision 2, and FSAR Tier 2 fire protection program (FPP) in accordance with SRP Section 9.5.1 and RG 1.189, Revision 1. The FPP is primarily described in FSAR Tier 1, Sections 2.1, 2.4, 2.5, 2.6, 2.7, 4.2, and 4.8 and FSAR Tier 2, Section 9.5.1, “Fire Protection System,” including Appendix 9A, “Fire Protection Analysis.” Additional portions of FSAR Tier 2, Revision 2 addressing aspects of the FPP that the staff reviewed for compliance with regulatory requirements include the following:

- Section 1.2.3.8.6, “Fire Protection System”
- Section 1.8.1, “COL Information Items”
    - Table 1.8-2, “U.S. EPR Combined License Information Items”
- Section 1.9, “Conformance with Standard Review Plan and Applicability of Codes and Standards,” including the following tables
    - Table 1.9-2, “U.S. EPR Conformance with Regulatory Guides”
    - Table 1.9-3, “U.S. EPR Conformance with TMI Requirements (10 CFR 50.34(f)) and Generic Issues (NUREG 0933)
    - Table 1.9-4, “U.S. EPR Conformance with Advanced and Evolutionary Light-Water Reactor Design Issues (SECY 93-087)
- Section 3.1.1.3, “Criterion 3—Fire Protection”
- Section 5.4.1, “Reactor Coolant Pumps”
- Chapter 7, “Instrumentation and Controls”

- Section 7.4.1.3, “Post-fire Safe Shutdown Systems”

- Section 8.3, “Onsite Power System”
  - Sections 8.3.1.1.9 and 8.3.2.1.5, “Independence of Redundant Systems”
- Section 9.1.3, “Fuel Pool Cooling and Purification System”
- Section 9.2.2, “Component Cooling Water System”
- Section 9.4, “Air Conditioning, Heating, Cooling, and Ventilation Systems”
- Section 9.4.13, “Smoke Confinement System”
- Section 9.5.2, “Communication System”
- Section 9.5.3, “Lighting System”
- Section 13.1, “Organizational Structure of Applicant”
- Section 13.4, “Operational Program Implementation”
- Section 14.2, “Initial Plant Test Program”
- Section 14.3, “Inspection, Test, Analysis, and Acceptance Criteria"
- Section 19.1.5, “Safety Insights from the External Events PRA for Operations at Power”
  - Section 19.1.5.3, “Internal Fires Risk Evaluation”
  - Section 19.1.5.4, “Other Externals Risk Evaluations”
  - Section 19.1.5.6, “Safety Insights from PRA for Other Modes of Operation”

The applicant provided the following additional information that supplements the information given in the FSAR sections and appendices referenced above as requested by the NRC:

- AREVA NP, Inc., Response to Request for Additional Information No. 20, Revision 0, U.S. EPR Standard Design Certification, Section 9.5.1, August 28, 2008
- AREVA NP, Inc., Response to Request for Additional Information No. 25, Revision 0, U.S. EPR Standard Design Certification, Section 9.5.1, September 9, 2008
- AREVA NP, Inc., Response to Request for Additional Information No. 20, Supplement 1, Revision 0, U.S. EPR Standard Design Certification, Section 9.5.1, September 5, 2008
- AREVA NP, Inc., Response to Request for Additional Information No. 20, Supplement 2, Revision 0, U.S. EPR Standard Design Certification, Section 9.5.1, October 31, 2008
- AREVA NP, Inc., Response to Request for Additional Information No. 25, Supplement 1, Revision 0, U.S. EPR Standard Design Certification, Section 9.5.1, December 5, 2008

- AREVA NP, Inc., Response to Request for Additional Information No. 151, Revision 0, U.S. EPR Standard Design Certification, Section 9.5.1, January 30, 2009
- AREVA NP, Inc., Response to Request for Additional Information No. 151, Supplement 1, Revision 0, U.S. EPR Standard Design Certification, Section 9.5.1, March 27, 2009
- AREVA NP, Inc., Response to Request for Additional Information No. 169, Revision 0, U.S. EPR Standard Design Certification, Section 9.5.1, February 23, 2009
- AREVA NP, Inc., Response to Request for Additional Information No. 169, Supplement 1, Revision 0, U.S. EPR Standard Design Certification, Section 9.5.1, April 15, 2009
- AREVA NP, Inc., Response to Request for Additional Information No. 196, Revision 0, U.S. EPR Standard Design Certification, Section 9.5.1, April 6, 2009
- AREVA NP, Inc., Response to Request for Additional Information No. 223, Revision 0, U.S. EPR Standard Design Certification, Section 9.5.1, July 9, 2009
- AREVA NP, Inc., Response to Request for Additional Information No. 277, Revision 0, U.S. EPR Standard Design Certification, Section 9.5.1, October 16, 2009
- AREVA NP, Inc., Response to Request for Additional Information No. 298, Supplement 2, Revision 0, U.S. EPR Standard Design Certification, Section 9.5.1, March 18, 2010
- AREVA NP Inc., Response to Request for Additional Information No. 337, Supplement 1, Revision 1, U.S. EPR Standard Design Certification, Section 9.5.1, March 1, 2010
- AREVA NP, Inc., Response to Request for Additional Information No. 337, Supplement 2, U.S. EPR Standard Design Certification, Section 9.5.1, March 19, 2010
- AREVA NP, Inc., Response to Request for Additional Information No. 351, Supplement 1, Revision 0, U.S. EPR Standard Design Certification, Section 9.5.1, April 15, 2010
- AREVA NP, Inc., Response to Request for Additional Information No. 406, U.S. EPR Standard Design Certification, Section 9.5.1, July 16, 2010
- AREVA NP, Inc., Response to Request for Additional Information No. 409, Revision 1 U.S. EPR Standard Design Certification, Section 9.5.1, August 12, 2010
- AREVA NP, Inc., Response to Request for Additional Information No. 375, Supplement 6, U.S. EPR Standard Design Certification, Section 9.5.1, October 15, 2010
- AREVA NP, Inc., Response to Request for Additional Information No. 391, Supplement 1, U.S. EPR Standard Design Certification, Section 11.3, June 22, 2010
- AREVA NP, Inc., Response to Request for Additional Information No. 443, Supplement 5, U.S. EPR Standard Design Certification, Section 9.5.1, May 18, 2011

- AREVA NP, Inc., Response to Request for Additional Information No. 482, Supplement 1, U.S. EPR Standard Design Certification, Section 9.5.1, July 29, 2011

- AREVA NP, Inc., Response to Request for Additional Information No. 482, Supplement 2, U.S. EPR Standard Design Certification, Section 9.5.1, August 30, 2011

The following is the Technical Review of the significant features of the FSAR Tier 2, Revision 2 FPP:

Fire Protection Program General Features

For the reasons set forth below, the staff concludes that the FPP and design of the FPS comply with applicable codes and standards.

In general, the FPP complies with the provisions specified in National Fire Protection Association (NFPA) 804, "Standard for Fire Protection for Advanced Light Water Reactor Electric Generating Plants," as they relate to the protection of post-fire safe-shutdown capability and the mitigation of a radiological release resulting from a fire. However, the NRC has not formally endorsed NFPA 804, and some of the guidance in the NFPA standard may conflict with regulatory requirements. When conflicts occur, the applicable regulatory requirements and guidance will govern.

Deviations from NFPA code requirements will be identified and justified by the COL applicant as part of the final plant specific Fire Hazards Analysis.

In accordance with SRP Section 9.5.1, "the standards of record related to the design and installation of fire protection systems and features sufficient to satisfy NRC requirements in all new reactor designs are those NFPA codes and standards in effect 6 months prior to the submittal of the application under 10 CFR Part 50 or 10 CFR Part 52. The codes/standards of record are governed by the DC (within 6 months of the DC document submittal date) for aspects of the FPP described in the DC."

"The COL should use industry codes and standards within 6 months of the COL application date for any aspects of the FPP not covered in the DC."

FSAR Tier 2, Revision 2, Table 9.5.1-1, "Fire Protection Program Compliance with Regulatory Guide 1.189," is a point-by-point description of the conformance of the U.S. EPR Fire Protection Program with the guidelines of RG 1.189, including alternative designs.

The FPP, including administrative controls and the fire brigade, are implemented prior to receiving fuel on site for fuel storage areas and for the entire station prior to reactor startup. See discussion for RAI 518, Question 09.05.01-87 below.

The FPS is designed to perform the following functions:

- Detect fires and provide operator indication of the location

- Provide the capability to extinguish fires in all plant areas, to protect site personnel, limit fire damage, and protect safe shutdown capabilities

- Supply fire suppression water at a flow and pressure sufficient to meet the largest hydraulic demand of any automatic sprinkler or water spray system with an additional 1893 lpm (500 gpm) for fire hose use, for a minimum of 2 hours

- Maintain 100 percent of fire pump design capacity, assuming failure of the largest fire pump or the loss of offsite power

- Following an SSE, provide water to hose stations for manual firefighting in areas containing Seismic Category I plant safe shutdown equipment

- Containment isolation

The FPP is designed to perform the following functions:

The FPS is part of the FPP. Therefore, the above FPS functions also apply to the FPP

- Prevent fire initiation by controlling, separating, and limiting the quantities of combustibles and sources of ignition.

- Isolate combustible materials and limit the spread of fire by subdividing plant buildings into fire areas separated by fire barriers.

- Provide protection for SSCs important to safety so that a fire, not promptly extinguished, will not prevent the safe shutdown of the plant or result in the release of radioactive materials to the environment.

- Maintain one success path of SSCs necessary to achieve safe shutdown conditions (i.e., cold shutdown) free of fire damage assuming all equipment in any one fire area will be rendered inoperable by fire, and post-fire re-entry for repairs or operator actions is not possible. Due to its physical configuration, the MCR is excluded from this approach, but an independent alternative shutdown capability that is physically and electrically independent of the MCR is included in the design.

- Provide fire protection features for redundant shutdown systems in the Reactor Building (RB) that will make sure to the extent practicable that one success path of SSCs necessary to achieve safe shutdown conditions (i.e., cold shutdown) is free of fire damage.

- Separate redundant divisions of safety-related equipment used to mitigate the consequences of a design basis accident (but not credited for safe shutdown following a fire) so that a fire within one division will not damage a redundant division.

- Prevent smoke, hot gases, or fire suppressant agents from migrating from one fire area to another to the extent they could adversely affect safe shutdown capabilities, including operator actions.

- Prevent failure or inadvertent operation of the FPS from impairing the safety capability of SSCs important to safety.

- Preclude the loss of structural support, due to warping or distortion of building structural members caused by the heat from a fire, to the extent that such a failure could adversely affect safe shutdown capabilities.

- Provide floor drains sized to remove expected firefighting water flow without flooding safety-related equipment.

- Provide firefighting personnel access and life safety escape routes for each fire area.

- Provide emergency lighting and communications to facilitate safe shutdown following a fire.

- Limit the radiological release to any unrestricted area due to the direct effects of fire suppression activities (but not involving fuel damage) to as low as reasonably achievable and to not exceed applicable regulatory limits.

The staff noted that descriptions of the Fire Protection System (FPS) and the FPP described in FSAR Tier 2, Sections 9.5.1, 9.5.1.1, 9.5.1.2.1, 9.5.1.6, and 9.5.1.6.2 were not clear in providing descriptions that conform to RG 1.189 Glossary definitions. The FPS should only include fire detection, notification, and suppression systems designed, installed, and maintained in accordance with the applicable nationally recognized codes and standards endorsed by the NRC while the FPP is all encompassing for fire protection activities. FSAR Tier 2, Sections 9.5.1 and 9.5.1.1 confused the content of the FPS with the content of the FPP. Therefore in RAI 443, Question 09.05.01-79, the staff requested that the applicant clarify the functions of and relationship between the FPS and FPP, in accordance with RG 1.189.

In a May 18, 2011, response to RAI 443, Question 09.05.01-79, the applicant stated that FSAR Tier 2, Sections 9.5.1, 9.5.1.1, 9.5.1.2, 9.5.1.2.1 and 9.5.1.6.3 will be revised so that the descriptions of the fire protection system and fire protection program conform to the glossary definitions provided in RG 1.189.

The staff reviewed the proposed FSAR revisions to revise FSAR Tier 2, Sections 9.5.1, 9.5.1.1, 9.5.1.2, 9.5.1.2.1 and 9.5.1.6.3 and finds the above response acceptable and considers this issue resolved since the definitions in RG 1.189 Glossary for FPP and FPS have been incorporated into the proposed revision. **RAI 443, Question 09.05.01-79 is being tracked as a confirmatory item.**

In RAI 518, Question 09.05.01-87, the staff requested the applicant's response to the following: FSAR Section 9.5.1 states that "The FPP, including administrative controls and the fire brigade, are implemented prior to receiving fuel on site for fuel storage areas and for the entire station prior to reactor startup." SRP 9.5.1 states that the Fire Protection Program should be fully implemented prior to fuel receipt at the plant site. The applicant should change the above to be acceptable to the staff and to be consistent with CCNPP3 as follows: "The FPP elements necessary to support receipt and storage of fuel onsite should be implemented prior to initial fuel receipt. The FPP elements necessary to support fuel load and plant operation should be implemented prior to initial fuel load." **RAI 518, Question 09.05.01-87 is being tracked as an open item**.

The staff finds that FSAR Revision 2 FPP general features conforms to the guidance of SRP Section 9.5.1 and RG 1.189, Regulatory Position C.1 except as described above in regard to RAI 443, Question 09.05.01-79 and RAI 518, Question 09.05.01-87.

<u>Fire Protection Program Changes</u>

FSAR Tier 2, Table 9.5.1-1,"Fire Protection Program Compliance with Regulatory Guide 1.189," indicates that conformance to RG 1.189, Regulatory Position C.1.8.1, "Change Evaluations," is the responsibility of the COL applicant. This COL action item is included in FSAR Tier 2, Table 1.8-2, “U.S. EPR Combined License Information Items as Combined License Information Item No. 9.5-6.” The staff finds the above acceptable.

Organization, Staffing, and Responsibilities

The FPP organization structure and the responsibilities for its establishment and implementation conform to the guidelines of RG 1.189. The COL applicant is responsible for determining the individual position responsible for the organizational functions described herein, as discussed in FSAR Tier 2, Revision 2, Section 13.1.

The individual with overall responsibility for the FPP has management control over all organizations involved in fire protection activities. Formulation and verification of FPP implementation may be delegated to a staff composed of personnel prepared by training and experience in fire protection and personnel prepared by training and experience in nuclear plant safety to provide a comprehensive approach in directing the FPP for the plant. The following organizational positions have been established for the FPP:

- An upper-level manager is responsible for formulating, implementing, and assessing the effectiveness of the FPP.
- Additional managers are directly responsible for formulating, implementing, and periodically assessing the effectiveness of the FPP. Results of these assessments and recommendations are reported to the upper-level manager responsible for the FPP.
- An onsite manager is responsible for the overall administration of the FPP which provides a single point of control and contact for all contingencies.
- The fire protection engineer
    - The responsibility for implementation of the FPP has been delegated to the fire protection engineer. The fire protection engineer is an individual knowledgeable through education, training, or experience (or a combination of the three) in fire protection and nuclear safety. Other personnel are available to assist the fire protection engineer as necessary.
    - The fire protection engineer is delegated responsibility for development and administration of the FPP including, but not limited to, administrative controls, periodic fire prevention inspections, FPS and FPS equipment inspections and testing, evaluations of work activities for transient fire loads, identification of fire protection training requirements, pre-fire planning, indoctrination training for all plant contractor personnel, and fire fighting training for operating plant personnel and the fire brigade.
- The nuclear training manager
    - Responsible for developing, scheduling and presenting fire protection training in accordance with the FPP.
- An onsite individual, responsible for fire protection Quality Assurance (QA)

- This person verifies the effective implementation of the FPP by planned inspections and scheduled audits, and the prompt reporting of the results of these inspections and audits to cognizant management personnel.

- The plant fire brigade for fighting fires
  - The authority and responsibility of each fire brigade position relative to fire protection is clearly defined and corresponds with the actions specified by the firefighting procedures.
  - Fighting fires is the primary responsibility of the fire brigade members and their other responsibilities do not adversely affect the ability of the fire brigade members to perform a credited fire fighting function.
  - The size of the fire brigade is based on the functions relied upon to fight credible and challenging fires for each operating shift with allowance for injuries, but includes at least five members per shift.
  - Fire brigade staffing accounts for all operational and emergency response demands on shift personnel in the event of a significant fire.

The staff finds that FSAR Revision 2 FPP organizational structure, staffing, and responsibilities shown above are consistent with the guidelines of SRP Section 9.5.1 and RG 1.189, Regulatory Position C.1.1.

Fire Protection Analysis (Fire Hazards Analysis)

The overall FPP allows the plant to maintain the ability to perform safe shutdown functions and minimize radioactive releases to the environment in the event of a fire. A major element of this program is the evaluation of potential fire hazards throughout the plant and the effect of postulated fires on safety-related plant areas. See FSAR Tier 2, Revision 2, Appendix 9A for the fire protection analysis (FPA). The FPA evaluates the potential for occurrence of fires within the plant and documents the capabilities of the fire protection system and provides reasonable assurance of the capability to safely shut down the plant. The FPA is an integral part of the process of selecting fire prevention, detection, and suppression methods, and provides a design basis for the fire protection system.

A COL applicant that references the U.S. EPR design certification will evaluate the differences between the as-designed and as-built plant configuration to confirm the Fire Protection Analysis remains bounding. This evaluation will be performed prior to fuel loading and will consider the final plant cable routing, fire barrier ratings, combustible loading, ignition sources, purchased equipment, equipment arrangement and includes a review against the assumptions and results contained in the Fire Protection Analysis. The applicant will describe how this as-built evaluation will be performed and documented, and how the NRC will be made aware of deviations from the FSAR, if any.

A COL applicant that references the U.S. EPR design certification will perform a supplemental Fire Protection Analysis for site-specific areas of the plant not analyzed by the FSAR. The FPA is performed for each fire area using the methodology described in FSAR Tier 2, Appendix 9A.2 discussed below. The methodology follows the guidance of RG 1.189.

Specific elements of the FPA methodology are as follows:

In accordance with GDC 3, structures, systems and components important to safety must be designed and located to minimize the probability and effect of fires and explosions. The requirements of GDC 3 are met, in part, by compartmentalization of the plant into separate fire areas. Specifically, based on the hazards present and the need for physical separation of SSCs important to safety, the plant is segregated into separate fire areas by passive, fire-rated structural barriers (e.g., walls, floors, and ceilings). In some instances (e.g., Reactor Building), a fire area is sub-divided into fire zones based on physical separation, location of plant equipment, or for FPA purposes. These fire areas and zones serve the primary purpose of confining the effects of fires to a single compartment or area, thereby minimizing the potential for adverse effects from fires on redundant SSCs important to safety. Outside of the control room and the Reactor Building, each of the redundant divisions of emergency core cooling is separated by three hour rated structural fire barriers.

Materials used in plant construction are noncombustible or heat resistant to the extent practicable in accordance with GDC 3. Walls, floors, roofs, including structural materials, suspended ceilings, thermal insulation, radiation shielding materials, soundproofing, and interior finish are noncombustible or meet applicable qualification test acceptance criteria unless otherwise justified. Concealed spaces are devoid of combustibles unless otherwise justified.

The plant layout also provides reasonable assurance that adequate means of access to all plant areas is provided for manual fire suppression activities and allows safe access and egress for personnel. The layout and travel distances of access and egress routes meet NFPA 101 to the extent practicable, unless otherwise justified. Potential delays in plant access or egress due to security locking systems are considered.

The in situ plant equipment and components, including electrical cables, housed within each fire area are considered. Any SSCs important to safety located within the fire area are considered.

In situ fire and explosion hazards associated with plant operations, maintenance, and refueling activities within the fire area are identified (e.g., cables, lube oil, diesel fuel oil, flammable gases, chemicals, building materials, and interior finish). In developing postulated fire scenarios for each fire area, the FPA considers the quantity and continuity of combustible materials, susceptibility of the materials to ignition, heat of combustion, heat release rates (HRR), and potential for fire spread.

In the event that a fire area could be subjected to potentially explosive environments from flammable gases or other potentially energetic sources (e.g., chemical treatment systems, ion exchange columns), explosion-prevention features and measures are provided.

External exposure hazards are identified (e.g., flammable and combustible liquid or gas storage, auxiliary boiler units, natural vegetation) that could potentially expose SSCs important to safety to fire effects (i.e., heat, flame, smoke). Wildfire hazards are addressed if the potential for damage to SSCs important to safety exists.

The credible in situ ignition sources within the fire areas are identified. The FPA classifies ignition sources as common or atypical and assigns potential fire severity levels on a generic basis using predefined guidance. Most in situ ignition sources are of the common type, which include electrical switchgear cabinets, general electrical and control cabinets, electric motors, pumps (i.e., reactor coolant pumps, feedwater pumps, and other pumps), diesel generators, air compressors, battery banks, boiler heating units, electric dryers, heating, ventilation, air conditioning (HVAC) subsystem components, and others.

Atypical sources of ignition include arcing electrical faults, hydrogen storage tanks, hydrogen piping, turbine generator exciter hydrogen, outdoor oil-filled transformers, and liquid fuels (i.e., spills). Due to their high energy nature, fires associated with atypical ignition sources are not assigned a generic intensity level.

Most anticipated fires will involve the common in situ ignition sources as represented by the equipment and components typically found in nuclear power plants. Such fires can be assessed using a fixed fire intensity (i.e., HRR) level for the given fire ignition source. However, consideration of a fixed fire intensity level for a given ignition source may not adequately consider the potential for low likelihood, high intensity fires. NUREG/CR-6850, addressed this concern by assigning a ranking of two HRR values. The first value assigned is the 75th percentile fire intensity. This means that 75 percent of the fires involving a given ignition source would reach an intensity no greater than the cited fire intensity (absent the fire propagating to any secondary combustibles). The second HRR value is the 98th percentile value, which is intended to represent a high confidence fire intensity value, which based on the industry guidance cited, is expected to bound the vast majority of fires involving a given ignition source.

Based on the in situ fire or explosion hazards and sources of ignition present within the fire area under consideration, postulated fire scenarios are developed and assessed. The FPA then assigns a hazard classification to each fire area. This classification is used as a broad characterization of the overall hazard assessment of each fire area. The classification system uses the same category and naming hierarchy as NFPA 13 for classification of building occupancies. However, as used herein, these classifications are only intended to be a simplified reflection of the positive correlation between fire severity and the quantity of fuel available to support combustion and the thermal properties (e.g., HRR) of the fuel. The HRR values shown for each fire area hazard classification are only intended to represent the level of intensity that would generally be expected for a fire of this type. These HRR values are not used as a basis for determining worst-case fire scenarios.

The predefined higher and lower HRR values associated with common ignition source fires and the corresponding FPA hazard classifications are provided in FSAR Tier 2, Table 9A-1.

Based on the type and nature of the plant equipment located in the area, the plant activities normally performed in the area, and the frequency of those activities, the FPA provides a transient hazard level (THL) assessment of transient fire hazards into the fire area analysis. A THL-1 determination generally reflects no need for detailed assessment of transient fire hazards. Depending on the type and quantity of in situ hazards within the area and its FPA hazard classification, a THL-2 determination may or may not reflect the need for detailed assessment of transient fire hazards. A THL-3 determination generally reflects the need for detailed assessment of transient fire hazards within the area analysis. In such cases, the material type, quantity, and associated thermal properties comprising the transient hazard package is evaluated. More than one type of transient hazard source may apply to a given fire area. FSAR Tier 2, Revision 2, Appendix 9A.2.3.3 provides additional information regarding the transient fire hazard determination process.

The FPA assesses postulated fires on a scenario-by- scenario basis and where quantitative and computational methods are applicable recognized fire protection engineering practices, methods and analytical tools, such as those promulgated by NUREG-1805, “Fire Dynamic Tools,” and NUREG-1824, Verification and Validation of Selected Fire Models for Nuclear Power Plant Applications,” will be appropriately applied and not the equivalent fire severity (British Thermal

Units (BTU)/sq ft) methodology. The equivalent fire severity methodology has generally been considered to be limited to light hazard occupancies, where combustible materials are evenly distributed over the floor area, the fuel is normal cellulosic materials such as wood or paper and the combustibles are located solely at the floor level which is typically not representative of the configuration and distribution of combustible materials located within U.S. EPR structures. For provision of fire protection features, regulatory requirements and regulatory guidance take precedence. Fire detection systems and fire suppression systems are provided for based on regulatory requirements as a priority and then on criteria such as the magnitude of the hazards in the area, plant damage, business interruption concerns, etc.

Risk-informed, performance-based methods, or other quantitative or computational methods or tools are not utilized to determine where fire detection and suppression systems will or will not be installed. However, where fire detection and suppression systems are provided in accordance with regulatory guidance, recognized fire protection engineering practices, methods and analytical tools, such as those set forth in NUREG-1805 and NUREG-1824 may be used to assess the performance capability of such systems.

The fire protection features provided (e.g., fire barriers and closure devices, fire detection systems, fire suppression systems and equipment) are designed and installed in accordance with applicable regulatory guidance, codes and NFPA standards. Deviations from the above requirements are justified.

Appropriate manual fire suppression capability (i.e., hydrants, standpipe and hose systems, and portable fire extinguishers) are specified and described for each plant fire area.

Pursuant to GDC 3, the potentially disabling effects of fire suppression systems, due to normal or inadvertent operation, on SSCs important to safety are described for each fire area.

The FPA describes the means provided to ventilate, exhaust, or isolate each fire area. Additionally, in accordance with SECY 90-016, the ventilation system design provides reasonable assurance 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 manual actions. See below subsections HVAC Design and Enhanced Fire Protection Criteria for evaluation.

For each fire area, the capability to protect SSCs important to safety from flooding associated with automatic and manual fire suppression activities, including inadvertent operation or fire suppression system failure, is considered. The effects of floor drains on the ability of total flooding gaseous fire suppression systems to achieve and maintain agent concentration upon discharge is considered for applicable fire areas.

In fire areas containing flammable or combustible liquids, the measures are provided to minimize the potential for fire propagation via the drainage system.

FSAR Tier 2, Table 9A-2 indicates the potential presence of radiological sources in a fire area. Possible radiological effects from a fire and the need for additional in-depth fire protection features to mitigate the consequences of a fire will be evaluated by the COL applicant as a part of the final Fire Hazards Analysis (FHA).

Emergency lighting credited to support fire suppression activities and post-fire safe shutdown operations, including access and egress routes to such locations, is described.

Plant communication systems, including hardwired and radio systems to provide effective communications between plant personnel performing safe shutdown operations, fire brigade personnel, and the main control room or alternative shutdown location, are described.

The scope of the FPA consists of the comprehensive assessment of the fire or explosion hazards for the plant structures in the following list, including a description of the fire protection defense-in-depth features provided to minimize the consequences of such an event.

- Reactor Building (UJA / UJB)
- Safeguard Buildings (1-4 UJH / 1-4 UJK)
- Fuel Building (UFA)
- Nuclear Auxiliary Building (UKA)
- Radioactive Waste Processing Building (UKS)
- Emergency Power Generating Buildings (1-4 UBP)
- Essential Service Water Pump Structures (1-4 UQB) and Cooling Tower Structures (1-4 URB)
- Access Building (UKE)

The staff reviewed FSAR Tier 2, Revision 2, Section 9.5.1.3 and Appendix 9A discussed above and finds the FPA conforms to the guidance of SRP Section 9.5.1 and conforms to the guidance in RG 1.189, Regulatory Position 1.2. The staff concludes that the FPA meets this guidance except as noted below since (1) it assesses postulated fires on a scenario-by- scenario basis and where quantitative and computational methods are applicable recognized fire protection engineering practices, methods and analytical tools, such as those promulgated by NUREG-1805 and NUREG-1824 will be appropriately applied and not the equivalent fire severity (BTU/sq ft) methodology which has generally been considered to be limited to light hazard occupancies; (2) for provision of fire protection features, regulatory requirements and guidance takes precedence over methodologies as those promulgated by NUREG-1805 and NUREG-1824; (3) risk informed performance based methods will not be utilized to determine where fire detection and suppression systems will or will not be installed; (4) FSAR Tier 2, Revision 2, Section 9.5.1.3 provides for a FPA as-built analysis and for a site-specific FPA; (5) FSAR Tier 2, Revision 2, Appendix 9A.3 includes detail such as type of suppression and detection; (6) FSAR Tier 2, Table 9A-2 includes detail such as where partial detection and suppression will be used applicable and where special emergency lights are necessary, which assists in determining design adequacy; and (7) FSAR Tier 2, Table 9A-2 indicates the potential presence of radiological sources in a fire area with possible radiological effects from a fire and the need for additional in-depth fire protection features to mitigate the consequences of a fire that will be evaluated by the COL applicant as a part of the final FHA. The staff also finds that it is acceptable to determine the need for automatic suppression or detection based on the FHA using the guidance in RG 1.189 and SRP Section 9.5.1 since SRP Section 9.5.1 states an applicant is required to identify differences between the design features, analytical techniques, and procedural measures proposed for its facility and the SRP acceptance criteria and evaluate how the proposed alternatives to the SRP acceptance criteria provide acceptable methods of compliance with NRC regulations, which are shown in below section Exceptions to SRP Section 9.5.7 and RG 1.189. FSAR Tier 2, Revision 2, Table 9.5.1-1 and FSAR Tier 2, Revision 2, Section 9.5.1.2.2 indentifies any alternative compliance with RG 1.189 and will be updated in accordance with SRP Section 9.5.1.

Fire Protection Analysis (Fire Safe Shutdown Analysis)

As described below, the U.S. EPR design provides a defense-in-depth post-fire safe-shutdown capability in accordance with the NRC acceptance criteria specified in NUREG-0800, SRP 9.5.1, Revision 5, including its Appendix A, and RG 1.189, Revision 1.

The U.S. EPR design provides reasonable assurance that adequate systems and equipment are available to achieve the following objectives in the event of a fire:

- Reactor coolant system process variables will be maintained within those predicted for a loss of normal AC power.
- The fission product boundary integrity shall not be affected (i.e., no fuel clad damage, rupture of any primary coolant boundary, or rupture of the containment boundary).
- One success path of the system necessary to achieve and maintain hot standby (HSB) conditions from either the MCR or RSS is free of fire damage as per RG 1.189. See discussion below for details.

The U.S. EPR post-fire safe-shutdown performance goals established to make sure that compliance with these objectives are the same whether performing actions from the MCR or RSS and are specified below.

- Reactivity control: The reactivity control function shall be capable of achieving and maintaining CSD reactivity conditions.
- Reactor coolant makeup: The reactor coolant makeup function shall be capable of maintaining the reactor coolant level within the level indication of the pressurizer.
- Reactor heat removal: The reactor heat removal function shall be capable of achieving and maintaining decay heat removal.
- Process monitoring: The process monitoring function shall be capable of providing direct readings of the process variables necessary to perform and control the previously listed functions.
- Support: The supporting functions shall be capable of providing the process cooling, lubrication, and other activities necessary to permit operation of equipment used for safe shutdown functions.

A COL applicant that references the U.S. EPR design certification will perform an as-built, post-fire Safe Shutdown Analysis, which includes final plant cable routing, fire barrier ratings, purchased equipment, equipment arrangement and includes a review against the assumptions and requirements contained in the Fire Protection Analysis. The post-fire Safe Shutdown Analysis will demonstrate that safe shutdown performance objectives are met prior to fuel loading and will include a post-fire safe shutdown circuit analysis based on the methodology described in NEI 00-01, “Guidance for Post-Fire Safe-Shutdown Circuit Analysis.”

Multiple spurious actuation methodologies will follow the NRC endorsed/issued spurious actuation guidance in effect when the U.S. EPR post-fire safe shutdown analysis is formally initiated. See discussion for RAI 517, Question 09.05.01-86 below.

The U.S. EPR design accommodates the SECY 90-016 analytical assumption that all equipment and cables within a fire area are considered rendered inoperable by the assumed fire and that post-fire safe-shutdown will be achieved via components and systems independent of the fire area under consideration and in addition, post-fire re-entry into a fire affected area for repairs or operator manual actions is not permitted except for the MCR, cable spreading areas, and the RB.

Redundant systems credited to support post-fire safe-shutdown are separated such that a minimum of one success path of structures, systems, and components necessary to achieve HSB and cold shutdown (CSD) is free of fire damage without crediting system repair capabilities. The term, “success path,” utilized in the design of the U.S. EPR is equivalent to the term, “one shutdown division,” discussed in SECY 90-016.

The post-fire safe shutdown analysis is not restricted to utilizing the strict divisional pair designations specified in FSAR Tier 2, Revision 2, Section 8.3. Any two divisions will support post fire safe-shutdown. This analysis takes advantage of the U.S. EPR N+2 design philosophy described in FSAR Tier 2, Revision 2, Section 1.2.3.1.1. Under this design philosophy, any one division may be out of service and of the three remaining divisions, the fire is assumed to affect one division, leaving two divisions available to support shutdown. Therefore, the divisions available may for example be Division 2 and 3, or 1 and 4, and does not need to match the divisional pair designations of FSAR Tier 2, Revision 2, Section 8.3. For the purposes of post-fire safe shutdown, a success path is comprised of any combination of available system divisions that achieve the shutdown performance goals specified in RG 1.189. The divisions credited depend upon the location of the postulated fire.

In evaluating the capability to accomplish post-fire safe-shutdown, offsite power may or may not be available and consideration is given to both cases. However, loss of offsite power need not be considered for a fire in non-alternative shutdown areas (i.e., outside of the control room) if it can be shown that offsite power cannot be lost because of a fire in that area.

For the U.S. EPR design, an operator manual action is defined as an action that takes place outside of the MCR in support of achieving and maintaining HSB from within the MCR. Operator manual actions associated with the credited shutdown success path are not needed to achieve and maintain HSB.

Associated circuits of concern are defined as those circuits containing cables that do not rely upon separation and:

- share a common power source with shutdown equipment that is not electrically protected from the circuit of concern by coordinated breakers, fuses or similar devices
- are directly connected to circuits of equipment that would adversely affect the shutdown capability if spuriously operated
- share a common enclosure that with the shutdown cables (1) is not electrically protected by circuit breakers, fuses or similar devices; or (2) will allow propagation of fire into the common enclosure

The U.S. EPR design provides circuit coordination for non-safe shutdown loads on shared buses and load centers. Cable installed in the plant complies with Institute of Electrical and Electronic Engineers (IEEE) Standard (Std) 1202, or equivalent, to preclude the potential for fire propagation. Non-shutdown cables that share a common enclosure with shutdown cables are electrically protected to provide reasonable assurance that faults are interrupted prior to cable damage. By virtue of this provision, the U.S. EPR plant design provides reasonable assurance that secondary fires do not occur as a result of fire-induced faults.

Alternative shutdown capability accommodates post-fire conditions where offsite power is available and where offsite power is not available for 72 hours. In evaluating safe shutdown circuits, including associated circuits the availability of uninterrupted power (i.e., offsite power available) may impact the ability to control the safe shutdown of the plant by increasing the potential for associated circuit interactions resulting from fire damage to energized power and control circuits.

Intentional station blackout (SBO) is not relied upon to mitigate potential fire damage to safe shutdown systems or associated circuits.

No credit is taken for digital equipment design features to preclude fire-induced spurious actuations and, therefore, smoke intrusion into digital equipment is not an issue.

Per RG 1.189, Revision 1, Section 5.6, shutdown operations are defined as refueling or maintenance outages. The U.S. EPR design provides reasonable assurance that fuel integrity is protected by permanent plant systems during refueling operations or maintenance outages. The primary fuel cooling systems are spent fuel cooling and the residual heat removal system. See discussion for RAI 482, Question 09.05.01-85 below.

For the U.S. EPR, low power operations are considered to be startup. For the purposes of analysis, startup operation is considered the same as power operation. Therefore, the analysis for post-fire shutdown is the same for both modes of operation.

The MCR is located in Division 2 of the Safeguard Building. The MCR is excluded from the separation criteria, because all four safety divisions of instrumentation and controls are present. Therefore, alternative shutdown capability is provided. This alternative shutdown capability is provided using the remote shutdown station (RSS) located in Division 3 of the Safeguard Building, which is physically and electrically independent of the MCR.

The MCR together with its adjacent room complex is one common fire area separated from other areas of the plant by its floor, walls, and roof, which have minimum fire resistance ratings of three hours. Peripheral rooms are separated from the MCR, including the shift office by non-combustible construction with a fire resistance rating of one hour. All other openings and penetrations through the barriers are afforded protective devices as necessary such as fire doors and penetration seals that meet a fire rating of 1 hour. All cables that enter the MCR terminate in the MCR. Specifically, no cables are routed through the MCR from one area to another. Cables enter the MCR by rising up from the cable spreading areas to the MCR sub-floor area. The sub-floor area is approximately 0.457 m (18 in.) high and constitutes part of the MCR fire area. Since there is a potential difficulty in accessing the MCR sub-floor areas for manual firefighting, the sub-floor areas are protected with a manually-actuated clean agent fire extinguishing system. Cable separation in the MCR sub-floor area conforms to the separation criteria in RG 1.75.

The cables to the MCR are routed through the cable floor. The cable floor is a separate fire area from the MCR assigned to Division 2 of the Safeguard Buildings. Safety-related cables from each of the other three divisions (1, 3, and 4) are routed from the cable floor to the MCR sub-floor area in the MCR via separate non-combustible cable ducts having a minimum fire resistance rating of 3 hours. Similarly, the RSS is located in its own fire area that is separated from other areas of the plant by its floor, walls, and ceiling, which have minimum fire resistance ratings of three hours. The RSS cable floor is its own fire area assigned to Division 3 of the Safeguard Buildings. Safety-related cables from each of the other three divisions (1, 2, and 4) are also routed from the RSS cable floor to the RSS via separate non-combustible cable ducts having a minimum fire resistance rating of 3 hours.

Post-fire safe shutdown systems in the FB are separated by three hour rated structural fire barriers.

The RB is a combination of the annulus area and the containment. The RB annulus area is used for cable connections between the four Safeguard Buildings and the RB, and for additional routing of mainly non-safety-related cables as well as physical protection of cables to the connected buildings. As such, the annulus area contains cabling allocated to all four safety divisions. The cable connections between Safeguard Buildings 1-4 and the divisional assigned components inside the RB are routed from the cable rooms in Safeguard Buildings via airtight penetrations to the annulus. In the annulus, the cables are routed to the connection boxes on both sides of the containment penetrations. Fire protection for redundant divisions is provided to make sure that one success path of SSCs necessary to achieve safe shutdown conditions (i.e., cold shutdown) is free of fire damage as follows. Specifically, division separation in the annulus is provided by 3-hour-rated fire barriers or a combination of spatial separation and defense-in-depth fire protection features such as fire barriers, fire rated cable, fire detection, fire suppression, and administrative controls to prevent storage of transient combustibles in the annulus.

The containment building contains all four divisions of electrical equipment and cabling. Division separation is provided by a combination of spatial separation, physical barriers, and defense-in-depth fire protection features such as fire detection and suppression systems which provide reasonable assurance that one success path of SSCs necessary to achieve safe shutdown conditions (i.e., cold shutdown) is free of fire damage. To conform to the criteria of RG 1.189, separation inside the RB is based on separation, as previously described, or separation of cables and equipment and associated non-safety-related circuits of redundant success paths is provided by a non-combustible radiant energy shield having a minimum fire rating of 30 minutes.

In RAI 482, Question 09.05.01-85, the staff requested that the applicant revise the FSAR for Shutdown/Low Power Operations to include any FPP systems, features, and procedures that would minimize the potential for fire events to impact safety functions (e.g., reactivity control, reactor decay heat removal, spent fuel pool cooling) or result in the unacceptable release of radioactive materials, under the differing conditions that may be present during shutdown operations.

In an August 30, 2011, response to RAI 482, Question 09.05.01-85, the applicant stated that U.S. EPR FSAR Tier 2, Section 9.5.1.2.1, will be revised to include the following statement:

> "For the U.S. EPR plant, shutdown operations are defined as refueling or maintenance outages. The primary fuel cooling systems are spent fuel pool cooling and residual heat removal systems. One or both of these systems are used depending on the location of

> the fuel. The U.S. EPR FPP consists of FPS design features, personnel, equipment and procedures that minimize the potential for fire events to affect the fuel integrity safety functions of reactivity control, decay heat removal, and spent fuel pool cooling or result in an unacceptable release of radioactive material under the different conditions that may be present during shutdown operations."

The staff reviewed the proposed FSAR revisions to revise EPR FSAR Tier 2, Section 9.5.1.2.1 and finds the above response acceptable. The staff considers this issue resolved since the spent fuel pool cooling or the residual heat removal systems will be available for use and since U.S. EPR FPP consists of FPS design features, personnel, equipment and procedures that minimize the potential for fire events to affect the fuel integrity safety functions of reactivity control, decay heat removal, and spent fuel pool cooling or result in an unacceptable release of radioactive material under the different conditions that may be present during shutdown operations and since the above is in accordance with the guidance of RG 1.189. **RAI 482, Question 09.05.01-85 is being tracked as a confirmatory item.**

In RAI 517, Question 09.05.01-86 the staff requested the applicant's response to the following:

The response to RAI 20 Question 09.05.01-6 stated that "NEI 00-01, Revision 1, "Guidance for Post-Fire Safe Shutdown Circuit Analysis," is the only formal NRC endorsed guideline currently available to the industry that addresses spurious actuations. Preparation of NEI 00-01, Revision 2 is in progress and has not yet been finalized or endorsed by the NRC. Until such time, it is endorsed by the NRC, utilization of NEI 00-01, Revision 2 is not considered appropriate. It is also not considered appropriate to independently develop assumptions and guidelines for the design of the U.S. EPR, as those developed may be inconsistent with the final industry/NRC product. It is the intent of the U.S. EPR design to follow the NRC endorsed/issued spurious actuation guidance in effect when the U.S. EPR post-fire safe shutdown analysis is formally initiated." However, RG 1.189 Rev. 2 and NEI 00-01 Revision 2 have since been issued. RG 1.189 Revision 2 contains the updated methodology for Post-Fire Safe Shutdown Circuit Analysis including multiple spurious actuations and also endorses certain sections of NEI 00-01 Revision 2. The applicant should document the use of RG 1.189 Revision 2 and the endorsed sections of NEI 00-01 Revision 2 in the FSAR for Post-Fire Safe Shutdown Circuit Analysis Methodology. **RAI 517, Question 09.05.01-86 is being tracked as an open item**

The staff reviewed FSAR Tier 2, Revision 2, Sections 9.5.1.2.1 and 9.5.1.3 and FSAR Tier 2, Revision 2, Appendix 9A discussed above and finds that the U.S. EPR Safe Shutdown Analysis is consistent with the guidelines of SRP Section 9.5.1; RG 1.189, Regulatory Positions C.1.3, 5, C.6, and C.8; SECY 90-016, except for areas discussed in this report in the section, "Exceptions to SRP 9.5.1 and RG 1.189"; and except as discussed above in RAI 482, Question 09.05.01-85 and RAI 517, Question 09.05.01-86. The Fire Safe Shutdown Analysis meets this guidance, in part, due to no credit being taken for digital equipment design features to preclude fire-induced spurious actuations, and multiple spurious actuation methodology following the NRC endorsed/issued spurious actuation guidance in effect when the U.S. EPR post-fire safe shutdown analysis is formally initiated; a success path being any combination of divisions; the cable floor being in a separate fire area from the MCR assigned to Division 2 with the other three divisions routed from the cable floor to the MCR sub-floor area in the MCR via separate non-combustible cable ducts having a minimum fire resistance rating of three hours; Division separation in the annulus being provided by three hour rated fire barriers or a combination of spatial separation and defense-in-depth fire protection features such as fire barriers, fire rated cable, fire detection, fire suppression; administrative controls to prevent storage of transient combustibles in the annulus; containment being separated by a combination of spatial separation, physical barriers, and defense-in-depth fire protection features such as fire detection, suppression systems, and non-combustible radiant energy shield having a minimum fire rating of 30 minutes; and the performance of an as-built post-fire Safe Shutdown Analysis.

Fire Prevention

Plant Design and Modification Practices

The staff reviewed FSAR Tier 2, Revision 2, Section 9.5.1.6.1 and determined the following:

Plant design and modification procedures include fire protection considerations that are in accordance with RG 1.189, Regulatory Position C.2.1.2. The procedures contain provisions that evaluate the impacts of modifications on installed FPSs and features, safe shutdown capability, potential for fire induced release of radioactive materials, and the potential to increase or modify (i.e., in a potentially adverse manner) the plant fire hazards. Procedures and practices related to the physical modification of the plant contain provisions that provide reasonable assurance that the modification process will not have adverse affects on the fire protection of the plant SSCs important to safety and during the implementation of the modification; an adequate fire protection impairment program is in place.

The staff finds the measures described above include all the guidance recommended in RG 1.189, Regulatory Position C.2.1.2.

Combustible Control Practices

Administrative procedures strictly control the use of flammable, combustible and hazardous materials in plant areas important to safety. Bulk storage of combustible and hazardous materials is not permitted inside or adjacent to buildings or systems important to safety. Use and control of transient combustible and hazardous materials (e.g., combustible liquids, wood and plastic products, dry ion exchange resins, hazardous chemicals) are governed by administrative control measures.

Combustible materials in the RSS and MCR are controlled and limited by administrative procedures to those necessary for operation.

Materials that collect or contain radioactivity, such as spent ion exchange resins, charcoal filters, and high efficiency particulate air (HEPA) filters, are protected and stored in accordance with RG 1.189 such that they should be stored in closed metal tanks or containers that are located in areas free from ignition sources or combustibles. See RG 1.189 for more details.

Plant administrative procedures clearly define the use, handling and storage of flammable and combustible liquids and gases. Flammable and combustible liquids are stored in accordance with NFPA 30. NFPA30 addresses fire and explosion prevention and risk control, electrical systems, storage, automatic fire protection, piping systems, etc. for flammable and combustible liquids. Specifically, compressed and liquefied flammable gases are stored in accordance with applicable NFPA codes. NFPA55 addresses hazardous materials, ignition source control, classification, explosion control, storage, uses, handling, etc., for compressed gases and cryogenic fluids. NFPA58 addresses low pressure gas equipment and appliances, low pressure gas installation, low pressure gas transfer, low pressure gas storage, low pressure gas transportation, buildings, engine fuel systems, operation and maintenance, piping, etc.

Storage and use practices for hydrogen are in accordance with guidance from NFPA 55. Hydrogen lines in safety-related areas are designed to Seismic Category I.

Ventilation systems designed to maintain the hydrogen concentration below one percent by volume are provided for battery rooms.

The turbine lubrication oil system, located in the Turbine Building, is separated from areas containing SSCs important to safety by 3-hour rated fire barriers. In addition, the turbine lubrication oil system is protected with automatic fixed fire suppression systems to maintain barrier integrity and make sure that a major Turbine Building fire does not adversely affect the ability to maintain operator control and safely shut down the plant. Automatic wet pipe sprinkler systems are provided for areas beneath the turbine operating floor, in the oil discharge tank room and lube oil room, and for lube oil lines above the turbine operating floor, including the turbine lagging/skirt and other areas that could accumulate oil as a result of a spill. Automatic pre-action sprinkler systems are provided for the turbine generator/exciter bearings and automatic water spray systems are provided for the hydrogen seal oil unit and lube oil drainage trenches.

Transformers located within buildings containing SSCs important to safety are of the dry type or are insulated and cooled with non-combustible liquid. Outdoor oil-filled transformers are separated from plant buildings in accordance with the guidelines in RG 1.189. Specifically, outside oil-filled transformers are separated from plant buildings by either distance or fire barriers. Where the distance from transformer to plant building is less than 152 m (50 ft), 3-hour fire-rated barriers without openings are provided for separation. In addition, each of the outdoor transformers is provided with an automatic deluge water spray system. Oil spill confinement is provided for each transformer by a gravel-filled, secondary containment and drainage system with adequate capacity to collect spilled oil and fire water. NFPA 80A is considered in the development of the qualification of fire barriers where exterior hazards exit. See subsection Compartmentalization, Fire Areas, and Zones / Passive Fire-Resistive Features for qualification details.

The diesel fuel oil main storage tanks and the diesel fuel oil service (i.e., day) tanks associated with the emergency diesel generators (EDGs) are located within the EPGBs that they serve. Each diesel fuel storage tank and diesel day tank are separated from the remaining portions of the building by 3-hour rated fire barriers. Potential spills from the tanks are confined by enclosures sized to accommodate more than the entire inventory of each tank. Automatic fire detection system capability is provided throughout the EPGBs. Additionally, each diesel fuel oil main storage tank and diesel day tank are protected by an automatic deluge (i.e., water spray) fire suppression system. Adequate drainage measures are provided for removing fire protection water and diesel fuel oil.

The reactor building internal structure walls form cubicles for each of the four RCPs. These cubicles are adjacent to, but separate from, each of the steam generator (SG) cubicles. The RCPs are physically separated from each other by either distance or solid concrete walls. The RCP motors are located above the RCPs and are separated by solid concrete walls. At the lower level (elevation 1.5 m (+5 ft)) below the RCPs, where there are no walls separating the RCPs, the RCPs are separated by more than 12.2 m (40 ft). The RCP motors each contain an upper and lower bearing that have independent oil lubrication systems. Both lubrication systems have an internal oil supply reservoir that is cooled with water via an oil cooler. The lower bearing has a cooling coil located within the reservoir. The upper bearing has an oil cooler remotely located from the reservoir. In addition, the upper lube oil reservoir is equipped with an external oil lift system remotely located from the reservoir, which is operated during the normal starting and stopping of the RCP motor. In the event of a lube oil leak a low oil level alarm is displayed in the MCR. Specifically, a description of how the lube oil collection system operates is discussed below.

An oil collection system is provided to collect and drain the motor lube oil (upper and lower bearing lube oil systems) in the event of leakage from the motor lubrication system. The oil collection system is designed in accordance with the fire protection requirements for RCP oil collection systems as presented in RG 1.189, Position 7.1. Where the lube oil system is capable of withstanding an SSE, the lube oil collection system is designed to provide protection for random leaks at mechanical joints in the lube oil system (e.g., flanges, sight glasses and drain valves). Where the lube oil system is not capable of withstanding an SSE, the oil collection system is designed to provide protection for the entire non-seismic portion of the lube oil system. The lube oil collection system is designed, engineered, and installed so that a failure in the lube oil system will not lead to a fire condition during normal or design basis accident conditions, and reasonable assurance is provided that the lube oil system will withstand an SSE.

The oil collection system collects lube oil leakage from potentially pressurized and unpressurized leakage sites in the RCP lube oil systems. The leakage is collected and drained to a vented closed container, located away from potential ignition sources. The container for each RCP is sized with sufficient capacity to hold the total of one RCP with margin. A flame arrester is provided if the flashpoint characteristics of the lube oil present a hazard of fire flashback.

Automatic fire detection system coverage is provided in the area surrounding each RCP. Additionally, the RCPs are protected by fixed water spray systems which are manually actuated from the MCR. These water spray systems provide water spray coverage over the surface area of the RCPs.

FSAR Tier 2, Revision 2, Section 5.4.1.2.2 for the RCP oil collection system states:

> An oil collection system is provided to collect and drain the motor lube oil (upper and lower bearing lube oil systems) in the event of leakage from the motor lubrication system. The oil collection system is designed in accordance with the fire protection requirements for RCP oil collection systems as presented in RG 1.189, Position 7.1. Where the lube oil system is capable of withstanding an SSE, the lube oil collection system is designed to provide protection for random leaks at mechanical joints in the lube oil system (e.g., flanges, sight glasses and drain valves). Where the lube oil system is not capable of withstanding an SSE, the oil collection system is designed to provide protection for the entire non-seismic portion of the lube oil system. The lube oil collection system is designed, engineered, and installed so that a failure in the lube oil system will not lead to a fire condition during normal or design basis accident conditions, and reasonable assurance is provided that the lube oil system will withstand an SSE.
>
> The oil collection system collects lube oil leakage from potentially pressurized and unpressurized leakage sites in the RCP lube oil systems. The leakage is collected and drained to a vented closed container, located away from potential ignition sources.

> The container for each RCP is sized with sufficient capacity to hold the total of one RCP with margin. A flame arrester is provided if the flashpoint characteristics of the lube oil present a hazard of fire flashback. A process and instrumentation drawing of the oil collection system is shown in Figure 5.1-4, Sheet 7 of 7.

The staff reviewed FSAR Tier 2, Revision 2, Sections 5.4.1.2.2 and 9.5.1.6.1 and finds these sections acceptable since potential oil leakage points external to the pump motor, such as the upper bearing oil cooler and external piping and equipment, including the oil coolers, are enclosed by the oil collection system and since the reactor coolant pump (RCP) lube oil collection system is designed in accordance with RG 1.189, Regulatory Position C.7.1.

The staff finds that the FSAR Revision 2 FPP control of combustibles conforms to the guidance of SRP Section 9.5.1 and RG 1.189, Regulatory Positions C.2.1 andC.7, as shown above.

Ignition Source Control Practices

Design, installation, modification, maintenance and operational procedures, and practices control potential ignition sources such as electrical equipment (i.e., permanent and temporary), hot work activities (e.g., open flame, welding, cutting and grinding), reactive chemicals, static electricity, and smoking.

- Hot work involving open flame or spark producing activities such as cutting, welding and grinding operations are governed by a permit system as required by station administrative controls. NFPA 51B guidance is considered in developing hot work administrative controls. Each task is reviewed, the work area is protected, and personnel that are trained to perform fire watch and suppress incipient fires are present during and after the work.

- Engineering design practices ensure that the electrical equipment is properly designed and installed in accordance with industry standards, heat generating equipment or equipment with hot surfaces is properly cooled or separated from combustible materials, and systems containing flammable and combustible liquids or gases are properly designed and located to minimize the exposure of these materials to ignition sources.

- Procedures and practices provide reasonable assurance that temporary power sources connected to plant systems are reviewed, evaluated, and documented including determination that the temporary service does not impact SSCs important to safety.

- Procedures and practices enable the control of temporary heating devices. Use of space heaters and maintenance equipment in plant areas are strictly controlled and reviewed by fire protection personnel.

- Procedures and practices provide reasonable assurance that temporary heating devices are properly installed and separated from combustible materials and surfaces.

- Potential ignition sources are controlled and limited in the MCR complex by administrative procedures.

The staff finds that the FSAR Revision 2 FPP control of ignition sources conforms to the guidance of SRP Section 9.5.1 and RG 1.189, Regulatory Position C.2.2.

Housekeeping

Plant cleanliness is maintained through administrative procedures and practices. Routine inspections are performed to make sure that plant conditions do not present unnecessary fire hazards or hazards to safe access to and egress from areas containing equipment important to safety. Operational and maintenance practices provide for timely response and cleanup for spills of chemicals or flammable and combustible liquids: removal of waste, refuse, scrap, and other combustibles resulting from daily operations and maintenance; and inspection of plant areas to verify that fire protection measures are properly implemented.

The staff finds that the FSAR Revision 2 FPP housekeeping conforms to the guidance of SRP Section 9.5.1 and RG 1.189, Regulatory Position C.2.3.

General Building and Building System Design (Passive Features)

Combustibility of Building Components and Features

Materials used in plant construction are non-combustible or heat resistant to the extent practicable in accordance with GDC 3. Walls, floors, roofs, including structural materials, suspended ceilings, thermal insulation, radiation shielding materials, soundproofing, and interior finishes are non-combustible or meet applicable qualification test acceptance criteria unless identified and suitably justified. American Society of Testing Materials (ASTM) E84, "Standard Test Method for Surface Burning Characteristics of Building Materials," NFPA 253, "Standard Method of Test for Critical Flux of Floor Covering Systems Using a Radiant Heat Energy Source," and NFPA 703, "Standard for Fire Retardant-Treated Wood and Fire-Retardant Coatings for Building Materials," are considered by the staff when evaluating the qualification of interior surface and finish materials. Concealed spaces are devoid of combustibles unless identified and suitably justified.

The cooling towers comply with RG 1.189, Regulatory Position C.6.2.6. The Essential Service Water Cooling Tower Structure is of noncombustible construction. The Circulating Water System Cooling Tower Structure is either of noncombustible construction or is located and protected in such a way that a fire will not adversely affect any systems or equipment important to safety. A COL applicant that references the U.S. EPR design will submit site-specific information to address the RG 1.189, Regulatory Position C.6.2.6, "Cooling Towers."

The staff finds that the FSAR Revision 2 FPP combustibility of building components and cooling towers conforms to the guidance of SRP Section 9.5.1 and RG 1.189, Regulatory Positions C.4.1.1 and C.6.2.6, as shown above.

Compartmentalization, Fire Areas, and Zones / Passive Fire-Resistive Features

In accordance with the requirements of GDC 3, SSCs important to safety must be designed and located to minimize the probability and effect of fires and explosions. The requirements of GDC 3 are met, in part, by compartmentalization of the plant into separate fire areas. Specifically, based on the hazards and the need for physical separation of SSCs important to safety, the plant is segregated into separate fire areas by passive, fire-rated structural barriers (i.e., walls, floors, and ceilings). In some instances, such as the Reactor Building, fire areas may be sub-divided into fire zones based on physical separation, location of plant equipment, or for fire hazard analysis purposes. These fire areas and zones serve the primary purpose of confining the effects of fires to a single compartment or area, thereby minimizing the potential for adverse effects from fires on redundant SSCs important to safety. Each of the four divisions of systems in the Safeguard Buildings, Essential Service Water Buildings, and Emergency Power Generating Buildings, are separated by 3-hour-rated structural fire barriers. Outside of the MCR and the RB, each of the four redundant divisions of emergency core cooling is separated by 3-hour-rated structural fire barriers.

Individual fire areas are separated by passive, fire-rated structural barriers (i.e., walls, floors and ceilings). Structural fire barriers are of non-combustible construction. Structural fire barriers are designed and installed to meet specific fire resistance ratings using assemblies qualified by fire tests. The qualification fire tests are conducted in accordance with, and meet the acceptance criteria of NFPA 251 or ASTM E119. The guidance from RG 1.189 was considered by the applicant for specifying the fire resistance ratings of fire area boundaries.

The plant layout also provides adequate means of access to all plant areas for manual fire suppression activities and to allow safe access and egress for personnel. The layout and travel distances of access and egress routes meet NFPA 101 to the extent practicable. Potential delays in plant access or egress due to security locking systems are considered.

The MCR is designed to permit rapid detection and suppression of fires, including the sub-floor and ceiling spaces.

The computer rooms outside the MCR in Safeguard Buildings 2 and 3 contain non-safety-related computers. These computer rooms are separated from each other and other areas of the plant by 3-hour fire rated barriers. The interfaces for the digital control system for each of the four safety divisions are located in the instrumentation and control cabinet rooms in their respective Safeguard Buildings. The instrumentation and control rooms are separated from each other by three-hour fire rated barriers. Automatic fire detection and manual fire protection by standpipe, hose, and portable extinguishers are provided for each computer room and instrumentation and control cabinet rooms.

The FPP is designed to preclude the loss of structural support due to warping or distortion of building structural members caused by the heat from a fire, to the extent that such a failure could adversely affect safe shutdown capabilities as determined from the fire protection analysis (FPA).

Except for specialty doors and closure devices, penetrations in fire area boundaries are provided with listed fire-rated door assemblies, shutter assemblies or listed rated fire dampers having a fire resistance rating consistent with the designated fire rating of the fire barrier. Fire door assemblies, fire dampers, and fire shutters used in 2-hour rated fire barriers are listed for not less than a 1.5 hour rating. However, where approved full-scale fire tests demonstrate that protection of fire barrier penetrations is not necessary; protection of such openings is not credited.

Except for specialty doors and closure devices, cable openings, piping openings and building joints are provided with penetration seals having a fire resistance rating consistent with the designated fire rating of the fire barrier. Such penetration seals meet the criteria of ASTM E814, "Standard Test Method for Fire Tests of Penetration Firestop Systems," UL 1479, "UL Standard for Safety Fire Tests of Through-Penetration Firestops," or IEEE Std 634, "Standard Cable Penetration Fire Stop Qualification Test," and IEEE Std 1202, "Standard for Flame-Propagation Testing of Wire and Cable." Materials used for penetration seals are a limited-combustible or non-combustible material in accordance with NFPA 259, "Standard Test Method for Potential Heat of Building Materials."

Openings inside conduits that penetrate fire rated barriers are sealed in a manner that maintains the fire rating of the barrier. Internal conduit seal locations are substantiated by fire testing.

Openings inside conduits that penetrate barriers relied upon to provide environmental isolation or pressure differentials are sealed with designs substantiated by pressure testing.

Specialty doors, closure devices or sealing components that are part of a fire barrier but are not listed or fire rated will be evaluated and justified as part of the final Fire Hazards Analysis (FHA). This activity will be performed by the COL applicant as part of the final FHA.

The staff finds that the FSAR Revision 2 FPP compartmentalization, fire areas, and zones conforms to the guidance of SRP Section 9.5.1 and RG 1.189, Regulatory Positions C.4.1, 4.2, and C.6.1.4 except as noted in this report in the section, “Exceptions to SRP 9.5.1 and RG 1.189.” These guidelines are met, in part, due to conduit seals being designed and tested to maintain the fire rating of the barrier and due to openings inside conduits that penetrate barriers relied upon to provide environmental isolation or pressure differentials being sealed with designs substantiated by pressure testing specialty doors, closure devices, or sealing components that are part of a fire barrier, but are not listed or fire rated being evaluated and justified as part of the FHA, and plant computer rooms conforming to RG 1.189, Regulatory Position C.6.1.4 for new reactor designs with individual digital control system servers located throughout the plant.

Electrical Cable System Fire Protection Design

Cable trays are constructed of metal. Only metallic tubing is used for conduits. Thin-wall metallic tubing is not used. Flexible metallic tubing is only used in short lengths. 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. Accordingly, the staff finds that electrical raceways are constructed to conform to the guidance of SRP Section 9.5.1 and RG 1.189.

Cable trays containing safety-related cables located inside containment are enclosed in non-combustible steel or steel composite materials.

The U.S. EPR design utilizes cables throughout the plant that have passed the flame propagation criteria of IEEE Std 1202. Self-ignition of these electrical cables is not considered credible because of the protective devices (e.g., fuses, circuit breakers) provided and analyzed to be properly sized.

Accordingly, the staff finds that the FSAR Revision 2 FPP electrical cable system fire protection design conforms to the guidance of SRP Section 9.5.1 and RG 1.189, Regulatory Position C.4.1.3.

Fire Detection and Suppression

Fire Detection and Alarm System

As described below, the plant fire detection and alarm system meets the guidance provided by SRP Section 9.5.1, RG 1.189, NFPA 72, “National Fire Alarm and Signaling Code,” and NFPA 70, “National Electrical Code.” The plant fire alarm system provides monitoring of all fire alarm detection devices and circuits, suppression system supervision and release when applicable, and plant specific area personnel notification. The plant fire alarm system annunciates a fire alarm, suppression and water supply system supervisory alarms, and overall fire alarm system trouble conditions at the main fire alarm panel located in the MCR.

The plant fire alarm system is provided with both an electrically supervised primary and secondary power source that transfers automatically to the secondary source upon the loss of the primary source. The loss of either power source annunciates a trouble condition to the main alarm panel in the MCR.

Fire detectors respond to smoke, flame, heat, or the products of combustion. Fire detectors are installed in accordance with NFPA 72 and the manufacturer recommendations. Specification of the most appropriate type of fire detector is determined as part of the fire protection analysis based on consideration of the type of hazard, type of combustion products, detector response characteristics, and other specified criteria (see FSAR Tier 2, Revision 2, Appendix 9A).

Fire detection is provided throughout the MCR in the U.S. EPR design, including inside cabinets and consoles.

Automatic and Manually Actuated Suppression

Where automatic fire suppression systems are provided, the staff finds they are designed and installed conforms to the guidance of SRP Section 9.5.1, RG 1.189, and applicable NFPA standards. RG 1.189 contains specific guidance for suppression in areas important to safety RG 1.189 also provides Nuclear Power Plant specific design and installation guidance for various types of suppression systems. Additional information concerning NFPA is provided below.

Failure, rupture, or inadvertent actuation of fire suppression systems will not significantly impair the safety capability of SSCs important to safety.

Automatic sprinkler systems designed and installed in accordance with NFPA 13 are provided for the following hazards. NFPA 13 addresses piping and component design, design flow rate, backflow, sprinkler coverage, level of protection guidance, hangers, etc.

1-2 EPGB and 3-4 EPGB

- Diesel Engine Hall

Fixed deluge water spray systems designed and installed in accordance with NFPA 15 are provided for the following hazards. NFPA 15 addresses piping and component design, design flow rate, backflow, sprinkler coverage, level of protection guidance, hangers, etc.

1-2 EPGB and 3-4 EPGB

- Emergency diesel generator (EDG) main fuel oil tanks (automatic actuation)

RB

- Reactor coolant pumps (manual actuation from the MCR)

Clean agent fire extinguishing systems designed and installed in accordance with NFPA 2001 are provided for the following hazards. NFPA 2001 addresses piping and component design, design flow rate, backflow, nozzle coverage, level of protection guidance, hangers, discharge time, holding period, agent concentration level, piping supports, etc.

Safeguard Buildings 2 and 3 electrical

- o MCR sub-floor area (manual actuation)

Since the MCR is occupied at all times while the plant is operating, and the subfloor area has a relatively small volume so that the quantity and location of ionization type fire detectors in the sub-floor area will provide early warning for timely response by MCR personnel, the design of the clean agent fire extinguishing system installed in the MCR sub-floor area is of manual-only actuation. While NFPA 2001 calls for clean agent fire extinguishing systems to be automatically actuated via a signal from the fire detection system, the standard does allow such systems to be of manual-only actuation if acceptable to the authority having jurisdiction.

The boundary of the MCR cable sub-floor area is adequately sealed to prevent a loss of clean agent, or the clean agent quantity is designed to compensate for loss of agent. The operations of the ventilation system, including agent distribution, maintenance of agent concentration during the soak time, and overpressure protection are integrated into the clean agent system design. The toxicity of the clean agent, including potential corrosive characteristics or effects of thermal decomposition products was considered. Measures are provided to verify the agent quantity of the storage cylinders and containers.

The clean agent fire extinguishing system is designed in accordance with NFPA 2001 and will deliver the design concentration within 10 seconds as per the standard and hold the design concentration for at least 15 minutes, which is the time credited for effective emergency action by trained personnel. The 15 minutes is 5 minutes more than the standard.

In view of the above, the staff finds that the FSAR Revision 2 FPP automatic and manually actuated suppression systems conforms to the guidance of SRP Section 9.5.1 and RG 1.189, Regulatory Position C.3.3, except as noted in this report in the section, “Exceptions to SRP 9.5.1 and RG 1.189.”

Fire Protection Water Supply, Fire Pumps, and Fire Mains

As set forth below, the staff finds that the site fire protection water supply system conforms to the guidance of SRP Section 9.5.1, RG 1.189, and applicable NFPA standards. The site fire protection water supply system contains two separate 100 percent dedicated capacity freshwater storage tanks of 1,135,624 liters (l) (300,000 gallons (gal)) or greater capacity, which meet the applicable portions of NFPA 22, three 100 percent capacity fire pumps (i.e., one electric motor-driven and two diesel engine-driven), which meet the applicable portions of NFPA 20, and an underground fire main yard loop designed in accordance with NFPA 24, that is, to furnish anticipated water flows. NFPA 20, 22, and 24 addressed hydraulic calculation piping losses, various pump types, acceptance testing, tank design, etc.

A COL applicant that references the U.S. EPR design certification will describe the program used to monitor and maintain an acceptable level of quality in the fire protection system freshwater storage tanks.

The portion of each tank dedicated to fire protection use is based on a 1893 lpm (500 gpm) outside hose stream allowance plus the largest hydraulic demand of any individual sprinkler system or fixed water spray (or deluge system) in accordance with NFPA 13 or NFPA 15.

Failure or rupture of one or both water storage tanks (when the FPS is in standby) will not significantly impair the safety capability of SSCs important to safety.

The site fire pump arrangement meets the applicable portions of NFPA 20, as follows. Three 100 percent capacity fire pumps (i.e., one electric motor driven and two diesel engine-driven) are provided. The capacity of each fire pump is adequate to supply a 1893 lpm (500 gpm) outside hose stream allowance and the largest flowrate of any individual sprinkler or fixed water spray (or deluge system), with the hydraulically least demanding portion of the underground fire main yard loop assumed to be out of service. Individual fire pump connections to the underground fire main yard loop are provided, with sectionalizing valves between connections. An electric motor-driven jockey pump is provided to automatically maintain fire protection water supply system pressure independent of the fire pumps.

Alarm indication provided in the MCR includes, but is not limited to, these functions:

- Fire protection water storage tank low level
- Fire pump running
- Fire pump driver availability
- Fire pump failure to start
- Fire protection water supply system low pressure

Each fire pump and its associated driver and controls are separated from each other and the plant by 3-hour fire-rated barriers. A separate fuel line and fuel oil storage tank is provided for each diesel engine-driven fire pump. Means other than sight tubes are provided for continuous indication of the amount of fuel oil in each storage tank. The floor around each fire pump and its associated driver and controls is pitched and adequate means for drainage are provided.

Control and sectionalizing valves are provided to isolate portions of the fire main yard loop for maintenance or repair without simultaneously shutting off the water supply to both fixed fire suppression systems, and standpipe and hose systems are provided for manual backup. Fixed fire suppression systems and standpipe and hose systems are connected to the main yard loop so that a single active failure or a pipe crack or break will not impair both primary and backup fire suppression capability.

Failure or rupture of any portion of the underground fire main yard loop will not significantly impair the safety capability of SSCs important to safety.

Outside fire hydrants are provided approximately every 76.2 m (250 ft) on the main yard loop. Additional hydrants are located near the entrances to the Essential Service Water Pump Building (ESWPB) and the Circulating Water Pump Building (CWPB). Valves are provided to permit isolation of outside hydrants from the fire main for maintenance or repair without interrupting the plant fire protection water supply capability. Hose houses equipped with fire hose and combination nozzle and other equipment specified by NFPA 24 are provided at intervals not exceeding 304.8 m (1000 ft), or alternatively, mobile means are provided which contain fire hose and the associated equipment specified by NFPA 24. Threads compatible with those used by local fire departments are used on fire hydrants hose couplings and standpipe system risers.

The FPS piping headers, fed from each end, are provided inside plant buildings or groups of buildings to supply both fixed fire suppression systems and standpipe and hose systems. As such, the supply headers are considered as an extension of the fire main yard loop.

The fire protection water supply system utilizes a three-ring header.

The fire water distribution system is shown in FSAR Tier 2, Figure 9.5.1-1, Fire Water Distribution System.

Failure or rupture of any portion of building supply headers will not significantly impair the safety capability of SSCs important to safety.

Standpipe and hose systems in areas containing equipment relied upon for safe plant shutdown following an SSE are designed to be functional following an SSE and capable of providing flow to at least two hose stations (approximately 284 lpm (75 gpm) per hose stream). The standpipe and hose stations in these areas, the water supply and distribution piping, and the supports and valves, as a minimum, satisfy the guidelines of ASME B31.1. This is accomplished by manually realigning valves to isolate non-seismically qualified portions of the FPS from the seismic portions of the system and manually starting the diesel fire pumps.

To conform to this guidance, portions of the fire protection water supply and water distribution system are designed to satisfy, as a minimum, the following criteria:

- Seismic design of the fire water storage tanks is in accordance with AWWA D100-2005, “Welded Carbon Steel Tanks for Water Storage,” referenced by NFPA 22, “Standard for Water Tanks for Private Fire Protection.” (refer to RG 1.189)

- The fire pump house is designed in accordance with ASCE 43-05, “Seismic Design Criteria for Structures, Systems, and Components in Nuclear Facilities,” with the seismic demand on the structure calculated for the site Safe Shutdown Earthquake (SSE).

- The two diesel fire pump drivers and fuel tanks, including their attachments and supports, are designed for seismic loads in accordance with ASCE 43-05. The limiting acceptable deformation, displacement or stress for the equipment support structures is characterized by Limit State C of the standard. Seismic demand on the SSCs being evaluated is based on the SSE for the site. The diesel pumps are design to be started manually following an SSE utilizing the pump batteries. Isolation valves which isolate the diesel fire pumps from the motor driven fire pump are designed to remain functional so that the cross connections to the motor driven pump can be manually closed after an SSE.

- Seismic design of the battery racks and anchors is in accordance with ASCE 43-05. The limiting acceptable deformation, displacement or stress for the battery support structures, including the anchorage, is characterized by Limit State C of the standard. Seismic demand on the SSCs being evaluated is based on the SSE for the site.

- The portion of the underground fire main which supplies fire protection water to the seismically qualified standpipe and hose system is designed to remain functional following an SSE. Isolation valves between seismically qualified portions of the underground fire main and non-seismically qualified portions shall remain functional following an SSE so that they can be manually closed.

- The portion of the inside fire water distribution system which supplies fire protection water to the seismically qualified standpipe and hose system is designed to remain functional following an SSE. Isolation valves between seismically qualified portions of the inside fire water distribution system and non-seismically qualified portions remain functional following an SSE so that they can be manually closed.

In RAI 482, Question 09.05.01-82, the staff requested that the applicant clarify the following issue summaries: FSAR Tier 2, Revision 2, Figure 9.5.1-1, “Fire Water Distribution System,” Sheets 4, 7, 8, and 13 apparently have drawing errors. Sheet 4 shows that point “T” connects to Sheet 11, but it should connect to sheet 13. Sheet 7 shows that point “P” connects to Sheet 11, but it should connect to sheet 13; point “R” connects to Sheet 6, but it should connect to Sheet 8. Sheet 8 shows that point “R” connects to Sheet 5, but it should connect to Sheet 7. Sheet 13 shows that point “T” connects to Sheet 2, but it should connect to Sheet 4; point “P” connects to Sheet 5, but it should connect to Sheet 7. The staff requested that the applicant revise FSAR Tier 2, Figure 9.5.1-1 to clarify these apparent inconsistencies and review FSAR Tier 2, Figure 9.5.1-1 for any other discrepancies and revise as needed.

In a July 29, 2011, response to RAI 482, Question 09.05.01-82, the applicant stated that U.S. EPR FSAR Tier 2, Figure 9.5.1-1, Fire Water Distribution System, Sheets 1 through 13, have been reviewed for discrepancies and that Sheets 1, 3, and 4 through 13 of this figure will be revised to remove existing discrepancies from fire water distribution system drawings.

The staff reviewed the proposed FSAR revisions to revise EPR FSAR Tier 2, Figure 9.5.1-1, Fire Water Distribution System, Sheets 1 through 13 and finds the above response acceptable and considers this issue resolved since the inconsistencies have been resolved. **RAI 482, Question 09.05.01-82 is being tracked as a confirmatory item.**

In view of the above the staff finds that FSAR Revision 2 for the fire protection water supply, fire pumps, and fire mains conforms to the guidance of SRP Section 9.5.1 and RG 1.189, Regulatory Position C.3.2 except as noted in this report in the section, “Exceptions to SRP 9.5.1 and RG 1.189,” and except as discussed above in regard to RAI 482, Question 09.05.01-82. The staff also finds that FSAR Revision 2 for standpipe and hose systems in areas containing equipment relied upon for safe plant shutdown following an SSE does adequately specify methods for seismic design of the fire water storage tanks, fire pumps and associated equipment to support fire water distribution SSE functional considerations.

Manual Firefighting Capabilities

Manual firefighting capability is provided throughout the plant to limit the extent of fire damage. Standpipe systems, hydrants, and portable equipment consisting of hoses, nozzles, and extinguishers are provided for use by fire brigade personnel. Manual fire suppression systems and equipment are designed and installed to comply with the guidance of SRP Section 9.5.1, conform to the guidance in RG 1.189, and applicable NFPA standards.

Interior manual hose installations are provided so that each plant location that contains, or could present a fire exposure hazard to, equipment important to safety can be reached with at least one effective hose stream. For all plant power block buildings on all floors, Class III standpipe systems, designed and installed in accordance with NFPA 14, “Standard for the Installation of Standpipe and Hose Systems,” are provided with hose connections equipped with a maximum of 30.48 m (100 ft) of .0381m (1.5 in.) diameter woven-jacket, lined fire hose, and suitable nozzles. Hose stations are located to facilitate access and use for firefighting operations. Alternative hose stations are provided if a fire hazard could block access to a single hose station serving a plant area.

Supply water distribution capability is provided for reasonable assurance of an adequate water flowrate and nozzle pressure for all hose stations. Hose station pressure reducers are provided where necessary for the safety of plant fire brigade members and offsite fire department personnel.

Automatic standpipe systems are provided throughout except in the Reactor Building and including the Reactor Annulus. Automatic standpipe systems are attached to a water supply capable of supplying the system demand at all times without reliance on any operator action other than opening a hose valve to provide water at hose connections. The Reactor Building, including the Reactor Annulus, has semiautomatic standpipe systems that are attached to a water supply capable of supplying the system demand at all times, but which rely upon activation of motor-operated control valves to provide full water supply to hose connections. In the inner Reactor Containment Building the inboard and outboard containment isolation, motor-operated control valves are normally kept closed and are only opened during a fire emergency in which the use of the standpipe system in the Reactor Containment Building is credited. In the Reactor Annulus there are two supply connections to the annulus standpipe system with a motor operated control valve in each connection. These supply connections are normally kept closed and only opened during a fire emergency in which the use of the standpipe system in the Reactor Annulus is credited. In addition, each of the control valves for the Reactor Annulus standpipe system has a 1 inch by-pass line which will keep the standpipe filled and pressurized.

Failure or rupture of standpipe and hose systems will not significantly impair the safety capability of SSCs important to safety.

Portable fire extinguishers are provided in all plant areas that contain or could present a fire exposure to equipment important to safety. The number, size, and type of fire extinguishers are provided in accordance with NFPA 10. In instances where radiological considerations may affect firefighting operations, portable fire extinguishers are pre-staged outside of the immediate area. Fire extinguishers are installed with due consideration given to possible adverse effects their use might have on equipment important to safety in the area.

The FSAR design allows for the use of portable smoke exhaust fan systems. FSAR Tier 2, Revision 2, Section 9.5.1.6.2 identifies that the fire protection engineer has responsibility for pre-fire planning. Pre-fire plans will address smoke control/removal on a fire area by fire area basis. FSAR Tier 2, Revision 2, Section 9.5.1.6.3 contains provisions for training fire brigade members in the use fire-fighting equipment, including ventilation equipment. FSAR Tier 2, Revision 2, Section 9.5.1.6.4 contains provisions for fire brigade members to conduct drills, which include assessing each fire brigade member's knowledge and use of fire-fighting equipment, including ventilation equipment. Each member of the fire brigade is equipped with a complete set of fire protection gear and the fire brigade has access to portable smoke removal equipment.

Failure or rupture of portable fire extinguishers will not significantly impair the safety capability of SSCs important to safety.

In RAI 482, Question 09.05.01-83, the staff requested that the applicant clarify the following issue summaries: FSAR Tier 2, Revision 2, Section 9.5.1.2.1, "Subsection Manual Fire Suppression Systems," states, "In the inner Reactor Containment Building the inboard and outboard containment isolation, motor-operated control valves are normally kept closed and are only opened during a fire emergency requiring the use of the standpipe system in the Reactor Containment Building." RG 1.189, Regulatory Position C.3.5.1.3 states that the pre-fire plans should include fire brigade actions such as operating instructions for use of the fire suppression systems and references NFPA 1620 which states that the pre-incident plan for all standpipe systems should include location and identification of control valves. Due to fire effects inside the Containment Building, the inboard valve may not be operable, MCR indication may not be available, and the fire brigade may need to manually operate this valve. The staff requested that the applicant ensure the inboard valve can be manually operated and that the pre-fire plans include this fire brigade action.

In a July 29, 2011, response to RAI 482, Question 09.05.01-83, the applicant stated that U.S. EPR FSAR Tier 2, Section 9.5.1.2.1 will be revised to include the following statement: "The inboard control valve can be manually operated. Prefire plans include this action for the fire brigade should automatic operation of the valve be rendered inoperable due to fire effects inside the Containment."

The staff reviewed the proposed FSAR revisions to revise EPR FSAR Tier 2, Section 9.5.1.2.1 and finds the above response acceptable and considers this issue resolved since the inboard control valve can be manually operated and since the prefire plans will include this action if necessary. **RAI 482, Question 09.05.01-83 is being tracked as a confirmatory item.**

The staff finds that FSAR Tier 2, Revision 2 FPP manual fire fighting capabilities conform to the guidance of SRP Section 9.5.1 and conform to the guidelines in RG 1.189, Regulatory Positions C.3.4, 3.5, and C.6.1.1.2 for containment for which standpipe and hose stations have been provided for inside containment, except as identified in RAI 482, Question 09.05.01-83 above.

Manual Fire Fighting Capabilities - Fire Brigade

The plant fire brigade has a minimum of five qualified members on site at all times. The fire brigade does not include the minimum shift crew necessary for safe shutdown or any personnel needed for other essential functions during a fire emergency. The fire brigade consists of a fire brigade leader who is assigned to the fire brigade and is qualified to assume command of a fire emergency and direct firefighting activities. The fire brigade also consists of an additional four fire brigade members who are qualified, trained, and equipped to respond to fire related emergencies.

Fire brigade drills are performed in the plant so that the fire brigade can practice as a team. Drills are performed at least quarterly for each shift fire brigade and each fire brigade member participates in at least two drills annually. At least one drill for each shift's fire brigade per year is unannounced. Persons planning and authorizing an unannounced drill make sure that the responding shift fire brigade members are not aware that a drill is being planned until it has begun. At least one drill per year is performed on a "back shift" for each shift's fire brigade.

The drills are preplanned to establish training objectives and the drills are critiqued. Members of the management staff responsible for plant safety and fire protection plan and critique unannounced drills. Performance deficiencies of a fire brigade or of individual fire brigade members are remedied by scheduling additional training. Unsatisfactory drill performance is followed by a repeat drill within 30 days. At three year intervals, qualified individuals independent of the plant staff critique a randomly selected unannounced drill.

Drills include the following:

- The effectiveness of the fire alarms; time used to notify and assemble the fire brigade; and selection, placement and use of equipment and firefighting strategies are assessed.

- Each brigade member's knowledge of his or her role in the firefighting strategy for the area assumed to contain the fire and the brigade member's conformance with established plant firefighting procedures and use of firefighting equipment, including self-contained breathing apparatuses, communication, lighting and ventilation is assessed.

- The simulated use of firefighting equipment to cope with the situation and type of fire selected for the drill is evaluated. The area and type of fire chosen for the drill vary from drill to drill to simulate fires in various areas of the plant. The situation selected simulates the size and arrangement of a fire that could reasonably occur in the area selected, allowing for fire development during the time needed to respond, obtain equipment and organize for the fire, assuming loss of automatic suppression capability.

- The brigade leader's direction of the firefighting effort is assessed with regard to thoroughness, accuracy, and effectiveness.

The plant fire brigade coordinates training with the local fire department so that responsibilities and duties are delineated in advance. This coordination is part of the training course and is included in the training for the local fire department staff. The local fire department is invited to participate in drills at least annually. Provisions for the offsite manual firefighting resources are in accordance with RG 1.189, Regulatory Position C.3.5.2.

Fire brigade members receive training as outlined in this section and below in this report in the section, "Fire Protection Training and Personnel Qualifications." Records of fire brigade member physical examinations, training drills, and critiques are maintained on file for a minimum of 3 years. NFPA 600 is used as guidance in the organization and training of the fire brigade.

Fire brigade equipment, including personal protective equipment for structural firefighting, is provided for the plant fire brigade in accordance with RG 1.189. Specifically, each fire brigade member is equipped with a helmet (with face shield), turnout coat, bunker pants, footwear, gloves, protective hood, emergency communications equipment, portable lights, portable smoke removal equipment, self-contained breathing apparatus and portable extinguishers. All equipment conforms to appropriate NFPA standards and is stored in accordance with manufacturer's recommendations. An adequate inventory of firefighting equipment is maintained to outfit a full complement of brigade members with consideration of the possibility of sustained fire response operations (i.e., multiple crews).

Based on the above, the staff finds that FSAR Revision 2 FPP fire brigade capabilities comply with the guidance of SRP Section 9.5.1 and conform to the guidance in RG 1.189, Regulatory Positions C.1.6.4 and C.3.5. These guidelines are met, in part, due to fire brigade equipment, including personal protective equipment for structural firefighting that conforms to RG 1.189, Regulatory Position C.3.5; due to fire brigade drills that conform to the guidelines in RG 1.189, Regulatory Position C.3.5.1.4; and due to training and organization that conform to the guidelines in RG 1.189, Regulatory Position C.1.6.4.

<u>Fire Protection Training and Personnel Qualifications</u>

Fire Protection Engineer

The individual responsible for developing and implementing the overall FPP is designated as the fire protection engineer. The fire protection engineer meets the educational and experience criteria necessary to be considered eligible for member grade (or professional member) status in the Society of Fire Protection Engineers (SFPE) or is a member (professional member) in the SFPE.

Fire Brigade Members

Fire brigade members complete initial training and qualification before serving on the plant fire brigade. This initial training includes individual responsibilities, identification of the type and location of fire hazards, and associated types of fires that could occur including the toxic and corrosive characteristics of expected products of combustion. The training identifies the location, proper use of fire fighting equipment, the correct method of fighting each type of fire including those in confined spaces, and familiarization with plant layout. The training also covers the proper use of communication, lighting, ventilation, and breathing equipment. Also covered are a detailed review of firefighting strategies and procedures, and a review of the latest plant modifications and corresponding changes in firefighting plans. Fire brigade leaders receive instruction on the direction and coordination of firefighting activities. Fire brigade members must also complete ongoing training and qualification. This training includes the following:

- Successful completion of an annual physical examination.
- Attendance at monthly on-shift training, when scheduled
- Attendance at quarterly fire fighting training
- Participation in quarterly drills (minimum two drills per year)
- Annual participation in a practice session that provides experience in actual fire extinguishment and the use of emergency breathing apparatus under strenuous conditions.
- Successful completion of a fit test for self-contained breathing apparatus every year

The fire brigade leader and at least two brigade members have sufficient training and knowledge of plant systems to understand the effects of fire and fire suppressants on safe shutdown capability. The fire brigade leader possesses an operator’s license or has the equivalent knowledge of plant systems, so that they can competently assess the potential safety consequences of a fire and advise MCR personnel.

Fire Protection System Operation, Testing and Maintenance

Functional groups responsible for FPS operation, maintenance, and testing are qualified by training and experience, and understand functions of the system.

Training of the Fire Brigade

The personnel responsible for the training of the fire brigade are qualified by knowledge, suitable training, and experience.

General Employee Training

Each nuclear plant employee has a responsibility to prevent, detect, and suppress fires. General site employee training introduces all personnel to the elements of the site-specific FPP, including the responsibilities of the FPP staff. Training includes information on the types of fires and related extinguishing agents, specific fire hazards at the site, and actions in the event of a fire suppression system actuation. General employee training provides specific instruction to site and contractor personnel on appropriate actions to be taken upon discovering a fire, actions to be taken upon hearing a fire alarm, administrative controls on the use of combustibles and ignition sources, and actions necessary in the event of a combustible liquid spill or gas release or leaks.

Fire Watch Training

Fire watch training provides instruction on fire watch duties, responsibilities, and required actions for both 1 hour roving and continuous fire watches. Fire watch qualification includes hands-on training in a practice fire with the extinguishing equipment to be used while on fire watch, and includes record keeping criteria.

The staff finds that FSAR Revision 2 FPP training and qualification acceptable since it complies with the guidance of SRP Section 9.5.1 and conforms to the guidelines in RG 1.189, Regulatory Position C.1.6.

HVAC Design

The design of the HVAC systems conform to the guidance of SRP Section 9.5.1 and RG 1.189. Safety-related HVAC systems are also designed in accordance with NFPA 90A. The HVAC design provides reasonable assurance that smoke, hot gases, or fire suppression agents (e.g., gaseous suppression agents) will not migrate into other fire areas and adversely affect safe shutdown capabilities, including operator actions.

The HVAC systems ventilate, exhaust, or isolate fire areas under fire conditions so that products of combustion do not spread to other fire areas. Ducts penetrating through fire area boundaries are provided with automatic fire dampers that have a fire rating equivalent to the rating of the barrier, or the ducts have a fire rating equivalent to the rating of the barrier and have no openings. Dampers are designed and tested to provide reasonable assurance of their operability under airflow conditions. Where practical, ventilation power and control cables for mechanical ventilation systems are located outside of the fire area served by the systems. Fresh air supply intakes to areas containing equipment or systems important to safety are located remotely from the exhaust outlets and smoke vents of other fire areas to minimize the possibility of contaminating the intake air with products of combustion.

The release of smoke and gases, containing radioactive materials, to the environment is monitored in accordance with RG 1.101. Where possible, isolation is provided where the release of smoke and gases could contain radioactive materials in a fire condition. However, where venting is relied upon, filtration equipment used to reduce doses is designed or protected to withstand the smoke and heat resulting from the fire. Ventilation systems designed to exhaust potentially radioactive smoke or gases have been evaluated to make sure that inadvertent operation or single failures do not violate the radiological controlled areas.

Plant operations staff is protected from the effects of fire and fire suppression (e.g., gaseous suppression agents) to provide reasonable assurance of safe shutdown of the plant including operator manual actions. The arrangement of the MCR, egress pathways, and the remote shutdown station (RSS) provide habitability in these areas. During normal operation and for a radiological event, the MCR is maintained at positive pressure with respect to the outside and adjacent areas. The design of the HVAC system places the MCR in recirculation mode for a fire outside the MCR so that any fires in these outside and adjacent areas will not affect the habitability of the MCR. Smoke and heat removal throughout the facility is provided by portable systems or by manual operation of the non-safety-related HVAC systems.

A smoke confinement system (SCS) for the Nuclear Island (NI) is provided to ensure habitability of the select egress paths between the MCR and RSS. A detailed description and operation of the SCS is discussed in FSAR Tier 2, Revision 2, Section 9.4.13. The design of the smoke confinement systems complies with NFPA 92A and NFPA 204. Egress pathways are maintained at higher pressure than adjacent areas to minimize smoke infiltration during a fire.

The smoke confinement system is normally in a standby mode and is automatically actuated by the fire alarm system or manually actuated as needed. The smoke confinement system consists of the Safeguard Buildings 2 and 3 interconnecting passageway supply and exhaust air subsystem, which provides outside air to pressurize the Safeguard Buildings 2 and 3 interconnecting passageway and the safeguard escape ladder shaft. The primary purpose of this system is to prevent in-leakage of smoke from adjacent areas.

Portable smoke exhaust fan systems (i.e., smoke ejectors) are also available for the controlled removal of heat, smoke, and other products of combustion from these and other areas of the plant.

As described below, the staff finds that the FSAR Revision 2 FPP HVAC design complies with the guidance of SRP Section 9.5.1 and in RG 1.189, Regulatory Positions C.4.1.4 and C.8.2. The staff finds it acceptable to limit the smoke confinement system to select egress paths between the MCR and RSS since either the MCR or the RSS will be used to achieve post-fire safe shutdown, and since operator manual actions associated with the credited shutdown success path are not relied upon to achieve and maintain HSB which would possibly require smoke removal. The resolution of the guidance in SECY 90-016 to ensure that smoke, hot gases or fire suppressant will not migrate into other fire areas to the extent that they could adversely affect safe shutdown capabilities, including operator actions is discussed in the section, "Enhanced Fire Protection Criteria," of this report.

<u>Communication</u>

For the purposes of fire fighting and operational post-fire safe shutdown activities, the U.S. EPR design relies on the portable wireless communication system described in FSAR Tier 2, Revision 2, Section 9.5.2.2.1. The system is multi-channeled and is capable of interfacing with the public address and digital telephone systems. Use of the portable wireless communication system does not interfere with the communications capabilities of the plant security force. Fixed components of the portable wireless communication system are protected as necessary from fire damage to provide seamless effective communication capability in all vital plant areas. With the use of low power portable radios, it is not anticipated that the exclusion zones will be wide enough to compromise effective communications within any vital area. In the event that specific exclusion zones are identified, an alternative means of communications via one of the fixed communication systems is provided. The type and location of the communication system devices for use in the exclusion zones is determined on an as-needed basis so that these are free of fire effects for any fire area in which communication is needed. The staff finds exclusion zone communication methodology acceptable since exclusion zones are usually narrow allowing prompt radio communication. The staff also finds exclusion zone communication methodology acceptable because if radios cannot be used efficiently another communication system will be provided that is free of fire effect. RG 1.189, Regulatory Position C.4.1.7(b) guidance will be met in all vital areas. Accordingly, the staff finds that FSAR Tier 2, Revision 2, Section 9.5.2.2.1 addresses capabilities of the portable wireless communication system and potential electromagnetic interference/radio frequency interference (EMI/RFI) effects.

RG 1.189, Regulatory Position C.4.1.7 considers the portable radio communication system to be separate from the fixed emergency communication systems. The public address communication system fulfills the recommendations for a fixed emergency communication system per Regulatory Position C.4.1.7.a. This regulatory position does not require a fixed emergency communication system to be dedicated to fire protection. The fixed emergency communication system only needs to be independent of the normal plant communication system. FSAR Tier 2, Sections 9.5.2.1 and 9.5.2.2 address the public address communication system design and capabilities. The public address communication system is installed at pre-selected locations and is independent of the normal fixed digital communication system. As independent, separate, and not dedicated to fire protection, the public address communication system does not need to meet the electrical separation requirements in RG 1.189, Regulatory Position C.5.3, with regard to other communication systems.

RG 1.189 states that the communication system design should provide effective communication between plant personnel in all vital areas during fire conditions under maximum potential noise levels. In RAI 20, Question 09.05.01-14, RAI 169, Question 09.05.01-67, RAI 298, Question 9.05.01-72, and RAI 409, Question 09.05.01-78, the staff requested that the applicant revise the FSAR to provide a brief description in Section 9.5.1 of the communication systems. RG 1.189, Regulatory Position C.4.1.7(b) guidance states, “A portable radio communications system should be provided for use by the fire brigade and other operations personnel required to achieve safe plant shutdown.” RG 1.189 also states, “Preoperational and periodic testing should demonstrate that the frequencies used for portable radio communication will not affect the actuation of protective relays.” Restricting radio use in sensitive locations to prevent spurious equipment operation is an exception to RG 1.189 guidance. The staff requested that the applicant follow RG 1.189 guidance to ensure radio communication is provided in all vital areas and to ensure that the radio frequencies used do not adversely affect digital equipment or provide additional details of why digital equipment is not being shielded, designed, installed, and tested such that there are no adverse digital equipment EMI/RFI radio effects. Additionally, the applicant must ensure that, if radios are not going to be used in restricted areas, that the backup communication system used is free of fire effects for any fire area that calls communication in restricted areas.

Further, RG 1.189, Regulatory Position C.4.1.7 considers the portable radio system separate from fixed emergency communications. RG 1.189, Regulatory Position C.4.1.7 does not call for a dedicated to fire protection fixed emergency communication system, rather that the fixed emergency communications only needs to be independent of the normal plant communication system. The term, “independent,” means a communication system that is a separate unrelated system from what is considered the normal communication system, but for which electrical separation does not need to be in accordance with RG 1.189, Regulatory Position C.5.3. Using two independent fixed communication systems is one way to satisfy the guidance of RG 1.189, Regulatory Position C.4.1.7.a. The staff requested that the applicant clarify how the FSAR conforms to RG 1.189, Regulatory Position4.1.7.a, given the above clarification.

In an August 28, 2008, response to RAI 20, Question 09.05.01-14, a February 23, 2009, response to RAI 169, Question 09.05.01-67, a March 18, 2010, response to RAI 298, Question 09.05.01-72, and an August 12, 2010, response to RAI 409, Question 09.05.01-78, the applicant added the following to FSAR Tier 2, Revision 2, Section 9.5.1.2.1:

> Communications
>
> For the purposes of fire fighting and operational post-fire safe shutdown activities, the U.S. EPR plant relies on the portable wireless communication system described in Section 9.5.2.2.1. The system is multichannel and is capable of interfacing with the public address and digital telephone systems. Use of the portable wireless communication system does not interfere with the communications capabilities of the plant security force. Fixed components of the portable wireless communication system are protected as necessary from fire damage to provide seamless effective communication capability in all vital plant areas. It is not anticipated, with the use of low power portable radios, that the exclusion zones will be wide enough to compromise effective communications within any vital area. In the event that specific exclusion zones are identified, an alternative means of communications via one of the fixed communication systems is provided. The type and location of the required communication system devices for use in the exclusion zones is determined on an as-needed basis so that these are free of fire effects for any fire area that requires communication. The intent of RG 1.189, Regulatory Position 4.1.7(b) guidance will be met in all vital areas. Section 9.5.2.2.1 addresses capabilities of the portable wireless communication system and potential EMI/RFI effects.
>
> RG 1.189, Regulatory Position 4.1.7 considers the portable radio communication system to be separate from the fixed emergency communication systems. The public address communication system fulfills the requirement for a fixed emergency communication system per Regulatory Position 4.1.7.a. This regulatory position does not require a fixed emergency communication system to be dedicated to fire protection. The fixed emergency communication system only needs to be independent of the normal plant communication system. Sections 9.5.2.1 and 9.5.2.2 address the public address communication system design and capabilities. The public address communication system is installed at pre-selected locations and is independent of the normal fixed digital communication system. As independent, separate, and not dedicated to fire protection, the public address communication system does not need to meet the electrical separation requirements in RG 1.189, Regulatory Position 5.3, with regard to other communication systems.

The staff reviewed the proposed revisions to FSAR Tier 2, Revision 2, Sections 9.5.1.2.1 and 9.5.2.2.1 and finds the above response acceptable and considers this issue resolved since the applicant has conformed to the guidance in RG 1.189, Regulatory Position C.4.1.7 by providing (1) the portable wireless communication system as the preferred communication method for fire fighting and operational post-fire safe shutdown activities; (2) a public address (PA) communication system which is designated as the fixed emergency communication system for the U.S. EPR; (3) the fixed digital communication system as the normal communication system for the U.S. EPR; also, (4) since the fixed PA communication system, installed at pre-selected locations, is independent of the plant normal fixed digital communication system; (5) since Independent means the PA communication system is a separate system from the digital communication system and electrical separation between the two systems need not be in accordance with RG 1.189, Regulatory Position C.5.3; (6) since, although an interface provision is included between the fixed PA communication system and the normal fixed digital communication system, a failure of one system does not affect the capability to communicate via the other system; (7) since, in the event that unexpected large exclusion zones are identified, an alternative means of communications via one of the fixed communication systems is provided that will be free of fire effects for any fire area that requires communication; and (8) since fixed components of the portable wireless communication system are protected as necessary from fire damage to provide effective communication capability in all vital plant areas.

The staff reviewed FSAR Revision 2 and verified that the proposed RAI 20, Question 09.05.01-14, revisions have been incorporated into FSAR Tier 2,Section 9.5.2.2.1 and that the revision to FSAR Tier 2,Section 9.5.1.2.1 has been supplemented by RAI 169, Questions 09.05.01-67, RAI 298, Question 09.05.01-72, and RAI 409, Question 09.05.01-78. Therefore, the staff considers RAI 20, Question 09.05.01-14 closed with issue unresolved. The staff reviewed FSAR Revision 2 and finds that the proposed RAI 169, Question 09.05.01-67 and RAI 298, Question 09.05.01-72 have been incorporated into FSAR Tier 2, Section 9.5.1.2.1, but has been supplemented by RAI 409, Question 09.05.01-78. Therefore, the staff considers RAI 169, Question 09.05.01-67 and RAI 298, Question 09.05.01-72 closed with issue unresolved. RAI 409, Question 09.05.01-78 has not been incorporated into FSAR Revision 2. **RAI 409, Question 09.05.01-78 is being tracked as a confirmatory item**.

Emergency Lighting

FSAR Tier 2, Revision 2, Section 9.5.3 contains design information for the U.S. EPR lighting system.

Portable hand-held, eight-hour rated lights are provided for use by the fire brigade in accordance with RG 1.189, Revision 1, Section 4.1.6.2b. The egress route from the MCR to the RSS is illuminated by independent fixed, self-contained eight-hour rated battery powered lighting units. Other post-fire safe shutdown activities performed by operators outside the MCR and RSS are supported by independent fixed, self-contained eight-hour rated battery lighting units at the task locations and in access and egress routes.

An alternative approach to fixed, self-contained 8-hour rated battery powered lighting units is taken for illuminating the MCR and RSS in support of post-fire safe shutdown. Both locations are illuminated by the special emergency lighting system. The special emergency lighting system receives power from redundant emergency diesel generator backed uninterruptible power supplies, thus providing continuous illumination. In the event a fire outside the MCR or RSS adversely affects special emergency lighting equipment, cables, or power supplies, adequate special emergency lighting is available in the MCR or RSS, as necessary, to facilitate post-fire safe shutdown of the plant. FSAR Tier 2, Table 9A-2, Fire Area Parameters, Emergency Lighting Note 10.dd, “Is provided by the special emergency lighting subsystem. This lighting consists of uninterruptible UPS backed lighting provided for operation of important to safety equipment,” is used to designate where special emergency lighting is used.

The location (fire area) of the self-contained battery backed fixtures will be determined during performance of the final post-fire Safe Shutdown Analysis identified as per COL Information Item No. 9.5-16.

The staff reviewed FSAR Tier 2, Sections 9.5.1.2.1, 9.5.3, and Table 9A-2 discussed above and finds that the emergency lighting acceptable since it is consistent with the guidelines of RG 1.189, Regulatory Position C.4.1.6 including the use of special emergency lighting in support of post-fire safe shutdown for illuminating the MCR and RSS in lieu of fixed, self contained 8-hour rated battery powered lighting units. The staff finds the special emergency lighting system acceptable since this lighting receives power from redundant emergency diesel generator backed uninterruptible power supplies, thus providing continuous illumination and since in the event of a fire outside the MCR or RSS which adversely affects special emergency lighting equipment, cables or power supplies, adequate special emergency lighting is available in the MCR or RSS, as necessary, to facilitate post-fire safe shutdown of the plant and since FSAR Tier 2, Table 9A-2 identifies the areas that need this special emergency lighting.

Inspection and Testing Requirements

The FPP addresses the inspection, testing, and maintenance of FPSs and features. Disabled or impaired FPSs and features are controlled by a permit system. Procedures and practices also establish appropriate compensatory actions for FPSs or features out of service or impaired.

The startup FPP Test Program is in accordance with FSAR Tier 2, Revision 2, Section 14.2.

Test plans are established that provide routine functional testing of FPSs and components. NFPA 25 (Reference 8) is considered in the development of the maintenance procedures. Fire barriers and installed assemblies and penetrations are periodically inspected and active components such as fire dampers and doors are functionally tested. Inspection and testing requirements for lighting and communication is in accordance with FSAR Tier 2, Revision 2, Sections 9.5.2 and 9.5.3.

These sections above, “Fire protection Training and Personnel Qualifications,” of this report describes that qualified personnel perform inspection, testing and maintenance of FPSs. Additionally, the section above, “Organization, Staffing, and Responsibilities,” describes that inspection and testing is documented and verified by the Fire Protection Engineer and the Fire Protection QA responsible individual.

The staff reviewed the FSAR Tier 2, Revision 2, Sections 9.5.1.4, 9.5.1.6.2, 9.5.1.6.3, 9.5.2, and 9.5.3 discussed above and finds the inspection and testing FPP features acceptable since it conforms to with the guidelines of RG 1.189, Regulatory Position C.1.7.5 by placing a program in place to perform installation and periodic testing under a quality assurance program and with testing documentation.

Quality Assurance

The overall plant quality assurance plan (QAP) includes the QA program for fire protection. The QAP provides reasonable assurance that the fire protection systems are designed, fabricated, erected, tested, maintained and operated so that they will function as intended. FSAR Tier 2, Revision 2, Section 17.5, states that the QAP for the design of the U.S. EPR design is addressed in AREVA NP Topical Report ANP-10266-A. The QAP implements quality requirements for the fire protection system that conform to the guidelines in RG 1.189, Regulatory Position C.1.7.

FSAR Tier 2, Revision 2, Section 17.2, states that a COL applicant that references the U.S. EPR design certification will provide the Quality Assurance Programs associated with the construction and operations phase. The program description to be provided by the applicant also includes a description of the fire protection system quality assurance program to be applied during fabrication, erection, installation and operations.

The staff reviewed FSAR Tier 2, Revision 2, Section 9.5.1.6.5, QA, and finds this section acceptable since the overall plant QAP includes the QA program for fire protection, and since the QAP provides reasonable assurance that the fire protection systems are designed, fabricated, erected, tested, maintained and operated so that they will function as intended. A COL applicant that references the U.S. EPR design certification will provide the Quality Assurance Programs associated with the construction and operations phase including a description of the fire protection system quality assurance program to be applied during fabrication, erection, installation and operations and since the FPP quality assurance program conforms to the guidance of SRP Section 9.5.1 and conforms to the guidelines of RG 1.189, Regulatory Position C.1.7.

Enhanced Fire Protection Criteria

Electrical system design and electrical separation is provided in accordance with the criteria specified in NUREG-0800, Section 9.5.1 and RG 1.189. The U.S. EPR design meets the enhanced fire protection criteria described in SRP Section 9.5.1 and SECY-90-016. SRP Section 9.5.1, Appendix A describes the criteria:

> Evolutionary advanced light water reactor (ALWR) designers must ensure that safe shutdown can be achieved assuming that all equipment in any one fire area will be rendered inoperable by fire and that re-entry into the fire area for repairs and operator actions is not possible. Because of its physical configuration, the control room is excluded from this approach, provided that an independent alternative shutdown capability that is physically and electrically independent of the control room is included in the design. Evolutionary ALWRs must provide fire protection for redundant shutdown systems in the reactor containment building that will ensure, to the extent practical, that one shutdown division will be free of fire damage. Additionally, the evolutionary ALWR designers must ensure that smoke, hot gases or fire suppressant will not migrate into other fire areas to the extent that they could adversely affect safe shutdown capabilities, including operator actions.

The fire protection shutdown capability demonstrates that the required number of divisions of equipment necessary to achieve and maintain safe shutdown remains available in the event of a fire at any location within the plant. RG 1.189 specifies that redundant systems used to mitigate the consequences of design basis accidents but are not necessary for safe shutdown may be lost to a single exposure fire. However, protection should be provided so that a fire within only one such system will not damage the redundant system. Therefore, the following separation criteria apply only to the electrical cabling needed to support the systems that are used for safe shutdown. The staff finds that the other redundant IEEE Class IE and associated cables meet the separation criteria of RG 1.75 as per EPR FSAR, Tier 2 Section, Revision 2, Section 7.1.2.4.5. When the electrical cabling is covered by separation criteria required for both safe shutdown and accident mitigation, the more stringent separation criteria would apply.

The U.S. EPR design incorporates the SECY 90-016 requirement that all equipment and cables within a fire area are considered rendered inoperable by the assumed fire and that post-fire safe-shutdown will be achieved via components and systems independent of the fire area under consideration and in addition, post-fire re-entry into a fire affected area for repairs or operator manual actions is not permitted except for the MCR, cable spreading areas, and the RB.

The U.S. EPR design is that redundant systems credited to support post-fire safe-shutdown are separated such that a minimum of one success path of structures, systems, and components necessary to achieve HSB and CSD is free of fire damage without crediting system repair capabilities. The term, “success path,” utilized in the design of the U.S. EPR is equivalent to the term, “one shutdown division,” discussed in SECY 90-016.

RG 1.189, Section 8.2 states that new reactor designs should ensure that smoke, hot gases or fire suppressant will not migrate into other fire areas to the extent that they could adversely affect safe-shutdown capabilities, including operator actions. To confirm that these objectives are satisfied for the U.S. EPR, a smoke effects analysis is performed. The analysis considers the location of redundant safe shutdown (SSD) equipment and components, the proximity of fire area boundaries, ventilation system operation, potential effluent types and quantities resulting from a fire, potential effluent migration paths, and the sensitivity of redundant SSD equipment and components to potential effluents.

For most areas of the plant, standard fire barriers and associated components (e.g., fire doors, fire dampers and penetration seals) provide the primary means to prevent migration of smoke, hot gas and fire suppressant between fire areas. Fire doors and fire dampers are in accordance with NPFA 80. Penetration seals in fire barriers are qualified for a fire rating equivalent to the hourly fire rating of the associated barrier. Penetration seal fire ratings will be determined by testing in accordance with the requirements of ASTM E814, UL 1479 or IEEE Std 634.

Where more robust fire barriers are deemed necessary to achieve these objectives, enhanced fire barrier features are used, as necessary, to control smoke, hot gas and fire suppressant migration. Enhanced fire barrier features may include smoke doors and smoke dampers to limit smoke propagation. Smoke doors are in accordance with NFPA 105. Ventilation penetrations in enhanced fire barriers are protected by combination fire and smoke rated dampers, or by fire rated dampers and separate smoke control dampers. Smoke dampers and combination fire/smoke dampers are installed, tested, and maintained in accordance with NFPA 80. Smoke dampers and combination fire/smoke dampers in enhanced fire barriers that are relied upon to control effluent migration will either close on smoke detection or will be closed via operator actions from the Control Room in response to an alarm from the fire detection system.

In the event of a Control Room evacuation, passage from the Control Room to the Remote Shutdown Panel is via the safeguard escape ladder shaft and the interconnecting passageway, which are protected by the SCS. The SCS egress pathways are maintained at higher pressure than adjacent areas to minimize smoke infiltration during a fire.

The staff reviewed FSAR Tier 2, Revision 2, Sections 9.5.1.2.1 and 9.5.1.7 and finds the above acceptable since (1) a smoke effects analysis will be performed as part of ITAAC closure to confirm that SECY 90-016 objectives are satisfied and since fire doors and dampers will be qualified in accordance with NPFA 80 and UL 555, respectively; (2) that penetration seals in fire barriers will be qualified for an F-rating equivalent to the hourly fire rating of the associated barrier and that penetration seal F-ratings will be determined by testing in accordance with the requirements of ASTM E814, UL 1479 or IEEE Std 634; (3) where more robust fire barriers are deemed necessary to achieve SECY 93-087 and SECY 90-016 objectives, enhanced fire barrier features will be used as necessary to control smoke, hot gas and fire suppressant migration. (Enhanced fire barrier features may include smoke doors and smoke dampers to limit smoke propagation. Smoke doors will be qualified in accordance with NFPA 105); (4) in the event of a Control Room evacuation, passage from the Control Room to the Remote Shutdown Panel is via the safeguard escape ladder shaft and the interconnecting passageway, which are protected by the SCS; (5) the FSAR allows for the use of portable smoke exhaust fan systems (FSAR Tier 2, Revision 2, Section 9.5.1.6.2 identifies that the fire protection engineer has responsibility for pre-fire planning. Pre-fire plans will address smoke control/removal on a fire area by fire area basis.) See the section below, "Inspections, Tests, Analysis, and Acceptance Criteria (ITAAC)," of this report for ITAAC related to control of smoke. The staff finds that FSAR Tier 2, Revision 2, FPP enhanced fire protection design conform to the guidance of SRP Section 9.5.1 and SECY 90-016, and conform to the guidance in RG 1.189, Regulatory Position C.8.

Exceptions to SRP Section 9.5.1 and RG 1.189

This subsection summarizes the staff's review of compliance issues where "Alternate Compliance" is indicated in FSAR Tier 2, Table 9.5.1-1.

Fire Areas

Generally, fire areas comply with RG 1.189, Regulatory Position C.4.1.2.1. Alternative compliance is provided for certain specialty doors and certain penetration seals.

Openings inside conduits that penetrate fire rated barriers are sealed in a manner that maintains the fire rating of the barrier. Internal conduit seal locations are substantiated by fire testing. Specialty doors, closure devices or sealing components that are part of a fire barrier but are not listed or fire rated, will be evaluated and justified as part of the final FHA. This activity will be performed by the COL applicant as part of the final FHA, as discussed in FSAR Tier 2, Revision 2, Section 9.5.1.3.

The staff reviewed FSAR Tier 2, Revision 2, Sections 9.5.1.2.1 and 9.5.1.2.2 and finds this alternative compliance acceptable since (1) conduit seals are designed and tested to maintain the fire rating of the barrier; (2) openings inside conduits that penetrate barriers required to provide environmental isolation or pressure differentials are sealed with designs substantiated by pressure testing; and (3) specialty doors, closure devices, or sealing components that are part of a fire barrier but are not listed or fire rated will be evaluated and justified as part of the FHA. See the section, "Compartmentalization, Fire Areas, and Zones / Passive Fire-Resistive Features," of this report for further details.

Control Room Complex

Generally, the control room complex conforms to the guidance in RG 1.189, Regulatory Positions C.6.1.2 and C.6.1.2.1. Alternative compliance is provided because of:

1. The lack of automatic water suppression for the peripheral rooms in the control room complex.

2. The gaseous fire suppression system being manually actuated via a local hand switch actuation by MCR operators, in lieu of automatic activation of the fire detection system for the sub-floor in the MCR. This is to preclude concerns regarding inadvertent activation of this fire extinguishing system.

Peripheral Rooms in the Control Room

The staff reviewed FSAR Tier 2, Revision 2, Section 9.5.1.2.2 and FSAR Tier 2, Table 9.5.1-1 and finds the lack of automatic water suppression systems for the peripheral rooms in the control room complex acceptable since the control room complex is constantly manned, will have area wide automatic smoke detection provided throughout including within cabinets and consoles, and will have manual fire suppression provided by standpipe and hose and portable extinguishers. Additionally, combustible materials and ignition sources are controlled and limited in the MCR complex by administrative procedures to those required for operation.

Under-Floor Areas of the MCR Complex

Fixed fire suppression capability in the form of a clean agent (gaseous) fire extinguishing system is provided for the MCR sub-floor area based on the considerations of RG 1.189, Regulatory Position C.6.1.2.1. However, to preclude concerns regarding inadvertent activation of this fire extinguishing system, clean agent gas release will be via local hand switch actuation by MCR operators, in lieu of automatic release by activation of the fire detection system. While NFPA 2001 requires clean agent fire extinguishing systems to be automatically actuated via a signal from the fire detection system, the standard does allow such systems to be of manual-only actuation if acceptable to the authority having jurisdiction.

Having the suppression system for the MCR sub-floor being manually actuated instead of automatically actuated is acceptable based on the MCR being manned at all times the plant is operating, and the relatively small volume of the sub-floor area, which provides reasonable assurance that the quantity and location of ionization type fire detectors in the sub-floor area will provide early warning for timely response by MCR personnel.

Electrical cable separation in the sub-floor area of the MCR conforms to the separation guidelines in RG 1.189, Regulatory Position C.4.1.3.4. As described in FSAR Tier 2, Revision 2, Section 7.1.2.4.5, redundant divisions of IEEE Class 1E electrical cables, which may be required to mitigate the consequences of design basis accidents, but are not relied upon to achieve post-fire safe shutdown, will conform to the separation guidelines in RG 1.75. This includes IEEE Class 1E electrical cables routed in the MCR sub-floor area. Additionally, IEEE Class 1E electrical cables located in the MCR sub-floor area will not be routed in fully enclosed electrical raceways which exceed .093 m sq (1 ft sq in.) cross-sectional area.

The boundary of the MCR cable sub-floor area is adequately sealed to prevent a loss of clean agent, or the clean agent quantity is designed to compensate for loss of agent. The operational requirements of the ventilation system, including agent distribution, maintenance of agent concentration during the soak time, and overpressure protection are integrated into the clean agent system design. The toxicity of the clean agent, including potential corrosive characteristics or effects of thermal decomposition products was considered. Measures are provided to verify the agent quantity of the storage cylinders and containers.

The clean agent fire extinguishing system is designed in accordance with NFPA 2001 and will deliver the design concentration within 10 seconds and hold the design concentration for at least 15 minutes, which is the time required for effective emergency action by trained personnel.

The basis for the acceptability of the manually operated clean agent (gaseous) fire extinguishing system in the MCR sub-floor area is as described below:

The hazards associated with the MCR under-floor area are not deemed to pose a deep-seated fire threat because (1) the conditions of the MCR sub-floor space are not consistent with those that typically lead to development of deep-seated fires; and (2) in the highly unlikely event that a deep-seated fire were to develop, there is reasonable assurance that the gaseous fire extinguishing system will control or suppress the fire until the arrival of emergency response personnel, consistent with the severity of the potential hazard and system design requirements of NFPA 2001.

The area being protected by the gaseous fire extinguishing system is a 0.457 m to 0.508 m (18 in. to 20 in.) high space under the MCR raised floor, where electrical cables are routed upward from the fire areas below, and then to terminations at various equipment locations in the MCR. The cables are typically for low voltage (120V) power applications and meet the flame self-extinguishment criteria of IEEE Std 1202 (2006). In addition, fiber optic cables are routed under the raised floor, which are comparable to IEEE Std 1202-rated cable from a flame propagation perspective. There are no credible ignition sources in the under-floor area, and there are no combustibles present other than the cables.

The clean agent gaseous fire extinguishing system is an engineered system designed to discharge halocarbon clean agent through a fixed piping network and discharge nozzles to provide a specified concentration of clean agent in the protected enclosure within a prescribed discharge time, and to maintain the design concentration until the arrival of emergency response personnel. The gaseous fire extinguishing system is manually actuated by control room operators upon activation of sub-floor ionization-type smoke detectors or upon the observation of MCR personnel. Any fire involving cabling in the under-floor is expected to be a slow developing, smoldering fire, emitting sufficient products of combustion to be detected by the ionization type smoke detectors and/or the MCR personnel during the incipient stages. The location and spacing of the ionization type detectors meet the specific requirements for raised floor applications prescribed by NFPA 72-2007.

As part of ITAAC, an enclosure integrity test will be performed to establish the total equivalent leakage area and enable a prediction to be made of the ability of the enclosure to retain the gaseous suppressant. Since some agent leakage through enclosure penetrations is expected, system performance will be validated by an acceptance test.

Pursuant to the design and performance capability of the clean agent gaseous fire extinguishing system, Section 5.6 of NFPA 2001 – 2004 states:

> [I]t is important that the agent design concentration not only shall be achieved, but also shall be maintained for the specified period of time to allow effective emergency action by trained personnel. This is equally important in all classes of fires, since a persistent ignition source (e.g., an arc, heat source, oxyacetylene torch or 'deep-seated' fire) can lead to resurgence of the initial event once the clean agent has dissipated.

Thus, based on NFPA 2001 - 2004, the potential hazard associated with deep-seated fires is mitigated by maintenance of the agent design concentration pending emergency personnel response.

For the MCR raised floor area, it is highly unlikely that the availability of the mechanisms for development of a deep-seated fire will be present. Specifically, as described in NUREG/CR-2431, "deep-seated fires were generated in the electrical cable tray tests by a hovering layer of burned gas. In horizontal cable trays such hovering gas was caused by a descending fire ball and/or a descending smoke blanket." Therefore, the location of a fire in the MCR raised floor area, as well as the porous construction of the raised floor, does not support development of deep-seated fires in this manner. Additionally, National Fire Protection Research Foundation, "Halon 1301 Discharge Testing: A Technical Analysis, "Dinenno and Budnick," states, "deep-seated cable array fires typically result from a long pre-burn condition or from large exposure fires." Combustible materials in the sub-floor space include minimal quantities of fiber optic and IEEE Std 1202-rated low-voltage cable. On this basis, a long pre-burn condition or a large exposure fire is not credible.

Dinenno and Budnick state, in summary, that the problem of deep-seated fires should be put in context. The impact of not extinguishing the locations in a fuel array that are undergoing condensed phase reaction may result in a re-flash or transition to flaming combustion. These re-flash conditions are expected to be slowly developing (on typical solid fuels) and typically they will not be immediately threatening.

NUREG-1805 states that the burning rate of deep-seated fires can be reduced by the presence of a clean agent, and they may be extinguished if a high concentration can be maintained for an adequate soaking time. It is normally not practical to maintain a sufficient concentration for a sufficient time to extinguish deep-seated fires. NUREG-1805 also states that extinguishment of a surface fire does not guarantee that a deep-seated fire will also be eliminated. Extinguishment of deep-seated fires requires an individual to investigate the interior of a material once the surface fire has been extinguished to determine if interior extinguishment has also been accomplished. Therefore, the gaseous fire extinguishing system is designed to extinguish a fire that is anticipated to develop and exhibit surface combustion, and would be relied upon to control or suppress fires that may exhibit deep-seated conditions. The potential hazard associated with deep-seated fires is mitigated by the response of emergency personnel in accordance with provisions of NFPA 2001 and the findings of NUREG/CR-2431, Dinenno and Budnick, and NUREG-1805.

The design concentration for the gaseous suppression system is below the highest concentration at which no adverse physiological or toxicological effect has been observed for the gaseous suppressant. However, due to the gaseous suppression system being located in the MCR envelope and the importance of maintaining habitability in the MCR, the applicant states that an inadvertent actuation of the system is undesirable and should be mitigated by making the system manually actuated. The applicant does not anticipate that making the system manually actuated will adversely affect the ability of the system to function properly due to the ionization detection in the under-floor area and the constant manning of the MCR.

The staff reviewed FSAR Tier 2, Revision 2, Sections 9.5.1.2.1, 9.5.1.2.2, and FSAR Tier 2, Tables 2.7.6-1 and 9.5.1-1 for a manually actuated instead of automatically actuated suppression system for the MCR sub-floor and finds FSAR Revision 2 acceptable for the following reasons: (1) the MCR will be manned at all times the plant is operating; (2) there is a relatively small volume of the sub-floor area which provides reasonable assurance that the quantity and location of ionization type fire detectors in the sub-floor area will provide early warning for timely response by MCR personnel; and (3) the use of ionization type detectors, designed and installed in accordance with specific raised floor application provisions prescribed by NFPA 72-2007, provide sufficient fire detection response capability to preclude evolution of an undetected smoldering, surface fire into a deep-seated fire. These items enable prompt actuation of the gaseous fire extinguishing system by MCR personnel; the nature of the electrical cable hazards located within the MCR raised floor area, and the configuration and construction of the raised floor area itself make development of a deep-seated fire highly unlikely. Therefore, delivery and establishment of the clean agent design concentration within 10 seconds and maintenance of this agent concentration for a 15 minute soak time provides adequate mitigation of a deep-seated fire scenario pending emergency personnel response. The ability of the MCR raised floor clean agent gaseous fire extinguishing system to achieve the required agent design concentration within 10 seconds, and the ability of the raised floor enclosure to maintain this concentration for 15 minutes is confirmed via ITAAC. The design concentration for the gaseous suppression system is below the highest concentration at which no adverse physiological or toxicological effect has been observed for the gaseous suppressant. However, due to the gaseous suppression system being located in the MCR envelope and the importance of maintaining habitability in the MCR, the applicant states that an inadvertent actuation of the system is undesirable and should be mitigated by making the system manually actuated. The applicant does not anticipate that making the system manually actuated will adversely affect the ability of the system to function properly due to the ionization detection in the under-floor area and the constant manning of the MCR. The staff also finds that the MCR sub-floor area conform to the separation guidelines of RG 1.75 as per EPR FSAR, Tier 2, Revision 2 Section 7.1.2.4.5, since the control room relies on alternate safe shutdown in lieu of safe shutdown separation. The staff finds this acceptable since for a fire in the MCR sub-floor which is part of the MCR fire area, safe shutdown is achieved by using alternate/dedicated shutdown RSS fire area which is separated from the MCR as per RG 1.189.

Electrical Cable System Fire Detection and Suppression

Generally, electrical cable systems conform to the guidelines in RG 1.189, Regulatory Position C.4.1.3.3. Alternative compliance is provided due to the lack of a fixed fire suppression system.

The U.S. EPR is a four divisional design. Generally, the cable systems for each of the four divisions outside the MCR, RSS, and RB are in divisional buildings (i.e., Safeguards and Emergency Diesel Generator Buildings and Essential Service Water Cooling Tower Structures). The buildings are separated from each other and other areas of the plant either by 3-hour fire-rated barriers or by sufficient distance to maintain adequate separation between divisions. Where a cable system for a safety division is located in a redundant divisional building such as the Division 2 main steam isolation valve cable systems in Safeguard Building 1, or for redundant divisional cable systems in the FB, the redundant cable systems divisions are separated by 3-hour fire-rated barriers. The RB annulus contains four safety divisions. Divisional separation is provided by 3-hour fire-rated barriers or a combination of spatial separation and defense-in-depth fire protection features, such as fire barriers, fire-rated cable, fire detection, fire suppression and administrative controls to provide at least one success path of SSCs necessary to achieve safe shutdown conditions (i.e., cold shutdown) is free of fire damage. Fire detection is provided in areas containing cables important to safety. Cable trays are accessible for manual fire fighting and manual fire protection is provided by hand hose and portable extinguisher capability.

Separation of each safety division from redundant divisions and the four safety divisions ensures that the loss of any one division does not impact safe shutdown capability. At the onset of the postulated fire, all safe shutdown systems (including applicable redundant divisions) are assumed operable and available for post-fire safe shutdown. Systems are assumed to be operational with no repairs (maintenance, testing, Limiting Conditions for Operations, etc.), in progress. The unit is assumed to be operating at full power under normal conditions and normal lineups. There is a high probability that even with a loss of one division from fire an extra division beyond the minimum required for safe shutdown will be available.

The U.S. EPR design utilizes electrical cable construction that has met the acceptance criteria of the IEEE Std 1202 test standard (or an equivalent standard) for prevention of flame propagation. IEEE Std 1202 is a vertical flame propagation test protocol. It is widely recognized that a vertical cable orientation represents a more severe fire test exposure than a horizontal cable orientation.

The staff reviewed FSAR Tier 2, Revision 2, Section 9.5.1.2.2, “Subsection Electrical Cable System Fire Detection and Suppression,” and FSAR Tier 2, Table 9.5.1-1 and finds this subsection and table acceptable because the cables for a given safety division are generally located in separate divisional Safeguard Buildings, which are separated from each other and other areas of the plant by a 3-hour fire-rated barrier. Therefore, a fire in one fire area would only result in a loss of one division with at least two divisions available to safely shutdown. Additionally, FSAR Tier 2, Revision 2, Section 9.5.1.2.1, "Subsection Electrical System Design and Electrical Separation," states that the only areas that do not meet SECY 90-016, "Enhanced Fire Protection," requirements to ensure safe shutdown can be achieved assuming that all equipment in any one fire area will be rendered inoperable by fire, are the MCR, cable spreading areas, and the RB for which SECY 90-016 provides alternate requirements for the MCR and the RB. Therefore, the staff finds that the only areas that do not meet the SECY 90-016 Enhanced Fire Protection requirements are the cable spreading areas whose alternate compliance is discussed below. Additionally, the U.S. EPR cables are qualified to the IEEE Std 1202 test standard (or an equivalent standard) to prevent fire propagation along the length of cables routed in trays located within a given fire area or zone fire. Cable trays are accessible for manual fire fighting and manual hose stations and portable extinguishers are provided throughout the plant. Additionally, fire detection is provided in areas containing cables important to safety.

Cable Design

The staff notes that cable design generally complies with RG 1.189, Regulatory Position C.4.1.3.1. Alternative compliance is provided for instances where special purpose cabling may not be qualified to IEEE Std 1202.

The staff notes that the U.S. EPR design generally utilizes electrical cable construction that meets the acceptance criteria of IEEE Std 1202. Instances where special purpose cabling does not comply with IEEE Std 1202 will be evaluated and justified as part of the final fire hazards analysis.

The staff reviewed FSAR Revision 2 and RAI 443, Question 09.05.01-80 proposed revision (See below for RAI details) and finds special purpose cabling may not be qualified to IEEE Std 1202. The staff finds this acceptable, however, since there will only be a small fraction of special cabling in the plant and since the FHA will justify the use of such cables and since FSAR Tier 2, Revision 2, Section 9.5.1.2.2 will be updated to reflect this alternative compliance.

Electrical Cabinets

Generally, fire areas comply with RG 1.189, Regulatory Position C.4.1.3.6. Alternative compliance is provided due to the lack of a fixed fire suppression system in rooms containing electrical cabinets important to safety and the lack of detection inside cabinets except in the MCR.

The U.S. EPR is a four divisional design. Generally, electrical cabinets for each of the four divisions outside the MCR, RSS and RB are in divisional buildings (i.e., Safeguards and Emergency Diesel Generator Buildings and Essential Service Water Cooling Tower Structures). The buildings are separated from each other and other areas of the plant either by 3-hour fire-rated barriers or the buildings are separated by sufficient distance to maintain adequate separation between divisions. Where electrical cabinets for a safety division are located in a redundant divisional building, such as the Division 2 Main Steam Isolation Valve (MSIV) cabinets in Safeguard Building 1 or for redundant divisional electrical cabinets in the FB, the electrical cabinets are separated by 3-hour fire-rated barriers. Area smoke detection is provided where safety-related electrical cabinets are located and manual fire protection is provided by hand hose and portable extinguisher capability.

Separation of each safety division from redundant cabinets and the four safety divisions make it so that the loss of any one safety division does not impact safe shutdown capability. At the onset of the postulated fire, all safe shutdown systems (including applicable redundant divisions) are assumed operable and available for post-fire safe shutdown. Systems are assumed to be operational with no repairs, maintenance, testing, (Limiting Conditions for Operations, etc.), in progress. The unit is assumed to be operating at full power under normal conditions and normal lineups. There is a high probability that even with a loss of one division from fire an extra division beyond the minimum required for safe shutdown will be available.

The staff reviewed FSAR Tier 2, Revision 2, Section 9.5.1.2.2, "Alternative Compliance With Regulatory Guide 1.189," Subsection Electrical Cabinets, and FSAR Tier 2, Table 9.5.1-1 and finds this alternative compliance acceptable since (1) fire detection is provided throughout the MCR, including inside cabinets and consoles and (2) due to the electrical cabinets for a given safety division being generally located in separate divisional Safeguard Buildings which are separated from each other and other areas of the plant by 3-hour fire–rated barriers where a fire in one fire area would only result in a loss of one division with one division beyond what is required to safely shutdown available. Additionally, FSAR Tier 2, Revision 2, Section 9.5.1.2.1, "Subsection Electrical System Design and Electrical Separation," states that the only areas that do not meet SECY 90-016 Enhanced Fire Protection requirements to ensure safe shutdown can be achieved assuming that all equipment in any one fire area will be rendered inoperable by fire are the MCR, cable spreading areas, and the RB for which SECY 90-016 provides alternate requirements for the MCR and the RB. Therefore, the staff finds that the only areas that do not meet the SECY 90-016 Enhanced Fire Protection requirements are the cable spreading areas whose alternate compliance is discussed below. Additionally, area smoke detection is provided where electrical cabinets are located and manual hose stations and portable extinguishers are provided throughout the facility.

Cable Spreading Room

Generally, the cable floor where all four safety divisions are routed to the MCR and the RSS conform to the guidelines in RG 1.189, Regulatory Position C.6.1.3. Alternative compliance is provided due to the lack of a fixed fire suppression system for the cable floor rooms.

The U.S. EPR does not have cable spreading rooms. Cables to the MCR are routed through the cable floor. The cable floor is a separate fire area from the MCR assigned to Division 2 of the Safeguard Buildings. Safety-related cables from each of the other three Divisions (1, 3, and 4) are routed from the cable floor to the MCR sub-floor area in the MCR via separate non-combustible cable ducts having a minimum fire resistance rating of 3 hours. Similarly, the RSS is located in its own fire area that is separated from other areas of the plant by floor, walls and ceiling having minimum fire resistance ratings of three hours. The RSS cable floor is its own fire area assigned to Division 3 of the Safeguard Buildings. Safety-related cables from each of the other three Divisions (1, 2, and 4) are also routed from the RSS cable floor to the RSS via separate non-combustible cable ducts having a minimum fire resistance rating of 3 hours.

Area-wide smoke detection is provided for the cable floor rooms and manual suppression is provided in the form of standpipe and hose and portable fire extinguishers. Combustibles are limited and the quantity of such combustibles is much less than anticipated in a cable spreading room because the majority of cables in this area are contained in noncombustible 3-hour fire-rated ducts.

The staff reviewed FSAR Tier 2, Revision 2, Section 9.5.1.2.2, "Alternative Compliance with Regulatory Guide 1.189," Subsection Cable Spreading Room and FSAR Tier 2, Table 9.5.1-1 and finds this alternate compliance acceptable since, due to the cable floor being in a separate fire area from the MCR assigned to Division 2 with the other three divisions routed from the cable floor to the MCR sub-floor area in the MCR via separate non-combustible cable ducts having a minimum fire resistance rating of 3 hours. Therefore, a fire in one fire area would only result in a loss of one division with at least two divisions available to safely shutdown. Additionally, area wide smoke detection is provided for the cable floor rooms and manual hose stations and portable extinguishers are provided throughout the facility and combustibles are limited and the quantity of such is much less than anticipated in a cable spreading room because the majority of cables in this area are contained in noncombustible 3-hour fire-rated ducts.

Switchgear Rooms

Generally, the plant switchgear rooms conform to the guidelines of RG 1.189, Regulatory Position C.6.1.5. Alternative compliance is provided due to the lack of a fixed fire suppression system for these rooms.

The U.S. EPR is a four division design. Each of the four divisional switchgear rooms is located in separate divisional Safeguard Buildings. Switchgear rooms are separated from other areas of the plant and Safeguard Buildings are separated from each other by 3-hour fire-rated barriers. Area-wide smoke detection is provided throughout the switchgear rooms and manual hose stations and portable extinguishers are provided throughout the facility.

Given that there are four safety divisions and each divisional switchgear room is in a fully separate building from redundant switchgear divisions, there is reasonable assurance that the loss of any one switchgear room does not to impact safe shutdown capability. There is a high probability that even with loss of one division from fire an extra division beyond the minimum required for safe shutdown would be available.

The staff reviewed FSAR Tier 2, Revision 2, Section 9.5.1.2.2, "Subsection Switchgear Rooms," and FSAR Tier 2, Table 9.5.1-1, RG Section C.4.2.3.3, Fire Stops for Cable Routing and finds this alternate compliance acceptable because the four divisional Switchgear rooms are located in separate divisional Safeguard Buildings which are separated by 3-hour-rated fire barriers. Therefore, a fire in one fire area would only result in a loss of one division with at least two divisions available to safely shutdown. Thus, a fire in one fire area would only result in a loss of one division, with one division beyond what is required to safely shutdown available.

Alternative compliance is provided for fire stops. The U.S. EPR utilizes cables throughout the plant that have passed the flame propagation criteria of IEEE Std 1202. Self-ignition of these electrical cables is not considered credible because of the protective devices (e.g., fuses, circuit breakers) provided and analyzed to be properly sized. While these cables are still considered combustible, they will not propagate fire unless subjected to an external fire involving other combustibles in the vicinity of the cable trays. In this case, the fire stops would be of little, if any, value in stopping the spread of fire. Fire stops would not stop the spread of fire in the area of influence of the exposure fire (i.e., area of the fire where temperatures are high enough to propagate fire along the cable trays) because they are only designed to prevent fire spread in the cable trays. Also, the IEEE Std 1202 qualified cables outside of the area of influence of the exposure fire would keep the fire from propagating and essentially serve the same purpose as the fire stops.

The staff reviewed the FSAR Revision 2 and RAI 443, Question 09.05.01-80 proposed revision (see below for RAI details), and finds that fire stops are not utilized by the U.S. EPR design. The staff finds the proposed revision acceptable since the use of IEEE Std 1202 (or equivalent) qualified cable that has met the acceptance criteria of flame propagation in the design of the U.S. EPR alleviates the need for fire stops and since FSAR Tier 2, Revision 2, Section 9.5.1.2.2 will be updated to reflect this alternative compliance.

Suppression Systems Inside Containment

The U.S. EPR design generally complies with RG 1.189, Regulatory Position C.6.1.1.2. Alternative compliance is provided for the RCP spray deluge systems that are manually actuated.

The spray deluge systems that are manually actuated are acceptable due to detection located in the same area as the RCP spray deluge systems being able to alert the MCR of a fire at the RCPs so that the spray systems can be actuated without undue delay. Also, having the systems in an automatic mode presents an unacceptable potential source of flooding in containment.

The staff reviewed FSAR Tier 2, Revision 2 and RAI 443, Question 09.05.01-80 proposed revision (See below for RAI details), and finds the above acceptable since: (1) manually actuated fixed deluge (or water spray) systems for the RCP Lube Oil System hazard are not required according to the guidance in RG 1.189, Regulatory Position 7.1; (2) suppression in containment is as per the FHA which is acceptable to use to determine fire suppression requirements in containment as per RG 1.189, Regulatory Position 6.1.1.2; (3) the FHA will demonstrate that division separation in containment is provided by a combination of spatial separation, physical barriers and defense-in depth fire protection features such as fire detection and suppression systems; (4) the detection located in the same area as the RCP spray deluge systems alerts the MCR of a fire at the RCPs so that the spray systems can be actuated without undue delay; (5) having the systems in an automatic mode presents an unacceptable potential source of flooding in containment; and (6) FSAR Tier 2,Revision 2, Section 9.5.1.2.2 will be updated to reflect this alternative compliance.

FSAR Section 9.5.1.2.2, alternative compliance with RG 1.189, does not include all the non-compliance issues listed in FSAR Tier 2, Table 9.5.1-1. FSAR Tier 2, Table 9.5.1-1, RG Sections C.6.1.1.2 (Containment Suppression), C.4.1.3.1. “Cable Design,” and C.4.2.3.3, “Fire Stops,” alternate compliances are not discussed in FSAR Tier 2, Section 9.5.1.2.2. Therefore, in RAI 443, Question 09.05.01-80, the staff requested that the applicant include these missing alternate compliance discussions in FSAR Tier 2, Section 9.5.1.2.2, provide a pointer to another FSAR section that discusses the issue, revise FSAR Tier 2, Table 9.5.1-1 as applicable, or provide the reasons for not including an issue.

In a May 18, 2011, response to RAI 443, Question 09.05.01-80, the applicant stated:

> U.S. EPR FSAR Tier 2, Sections 9.5.1.2.1 and 9.5.1.2.2, and Table 9.5.1-1_Fire Protection Program Compliance with Regulatory Guide 1.189 will be revised to include information on alternative compliance with RG 1.189 for Cable Design (C.4.1.3.1), Fire Stops for Cable Routing (C.4.2.3.3), and Containment Fire Suppression (C.6.1.1.2).
>
> U.S. EPR FSAR Tier 2, Table 1.9-2_U.S. EPR Conformance with Regulatory Guides will be revised to reflect that the U.S. EPR design uses an alternative

approach to the NRC guidance with respect to complying with regulatory positions in RG 1.189. U.S. EPR FSAR Tier 2, Section 9.5.1 describes the alternative compliance with specific regulatory positions in RG 1.189.

Technical Report ANP-10292, Revision 1, "U.S. EPR Conformance with Standard Review Plan (NUREG-0800)," has been revised to reflect that the U.S. EPR design uses an alternative approach relative to the NRC guidance with respect to complying with regulatory positions in RG 1.189.

The staff reviewed the May 18, 2011, proposed response to RAI 443, Question 09.05.01-80 to update FSAR Tier 2, Sections 9.5.1.2.1, 9.5.1.2.2 and FSAR Tier 2,Tables 9.5.1-1 and 9.5.1.9-2 and Technical Report ANP-10292 and finds these updates acceptable as per above staff reviews for the Cable Design, Fire Stops, and Suppression Systems Inside Containment alternate compliance subsections, and since Tables 9.5.1-1 and 1.9-2 and Technical Report ANP-10292 have been updated properly to reflect the above updates, and since the FSAR and ANP-10292 will be updated to reflect these alternative compliances. **RAI 443, Question 09.05.01-80 is being tracked as a confirmatory item.**

ITAAC

ITAAC: FSAR Tier 2, Table 2.1.1-8, "Reactor Building ITAAC," Item 2.7 requires analysis, inspection, and testing to be performed for fire protection, safe-shutdown, smoke, damper, barrier, door, and penetration features of the 3-hour fire rated barrier separation between the RBA, Safeguard Buildings, and the FB. FSAR Tier 2, Table 2.1.1-10, "Safeguard Buildings ITAAC," Item 2.2 requires analysis, inspection, and testing to be performed for fire protection, safe-shutdown, smoke, damper, barrier, door, and penetration features of the 3-hour fire rated barrier separation between the four Safeguard Buildings. FSAR Tier 2, Table 2.1.1-11, "Fuel Building ITAAC," Item 2.2 requires analysis, inspection, and testing to be performed for fire protection, safe-shutdown, smoke, damper, barrier, door, and penetration features of the 3-hour fire rated barrier separation between the individual divisions of the FB and between the FB and the NI. FSAR Tier 2, Table 2.1.2-3, "Emergency Power Generating Building ITAAC," Item 3.3 requires analysis and inspection to be performed for fire protection, smoke, damper, barrier, door, and penetration features of the 3-hour fire rated barrier separation between the individual divisions of the EPGBs. FSAR Tier 2, Table 2.1.5-3, "Essential Service Water Building ITAAC," Item 3.4 requires analysis and inspection to be performed for fire protection, smoke, damper, barrier, door, and penetration features of the 3-hour fire rated barrier separation between the individual divisions of the ESWBs. FSAR Tier 2, Table 2.2.1-5, "RCS ITAAC," Item 3.19 requires analysis and inspection of the RCP Lube Oil Collection System. FSAR Tier 2, Table 2.4.2-2, "Safety Information and Control System ITAAC," Items 4.1, 4.3, 4.6 and 4.7 require an inspection to verify the capability to transfer control from MCR to RSS and that electrical isolation is provided between RSS and the MCR for the SICS and between the SICS and between the non-ASME Code Class 1E equipment. FSAR Tier 2, Table 2.4.6-2, "Plant Fire Alarm System ITAAC," Item 2.1 requires testing to verify the existence of the displays on the process information and control system (PICS) at both the MCR and RSS. FSAR Tier 2, Table 2.4.6-2, Item 2.2 requires an inspection report to document that the as-built plant fire alarm system is consistent with the post-fire safe-shutdown analysis. FSAR Tier 2, Table 2.4.6-2, Item 3.1 requires testing of the normal and backup power supplies to the PFAS and the associated indications. FSAR Tier 2, Table 2.4.10-1, "Process Information and Control System ITAAC," Items 2.4 and 2.5 require an inspection to verify that electrical isolation is provided between RSS and the MCR for the PICS capability to transfer control of the PICS from the MCR to the RSS. FSAR Tier 2, Table 2.4.21-2, "Communication System ITAAC," Item 2.1

requires tests to be performed on the digital telephone system, the public address and alarm system, the sound powered system, and the portable wireless communication system to verify they exist and that they function as required. Items in FSAR Tier 2, Table 2.5.9-1, “Lighting System ITAAC,” require tests to demonstrate adequate illumination for the MCR, RSS, and for areas outside of the MCR and RSS including egress routes from the MCR to the RSS and requires analysis to determine where emergency light battery packs are required. FSAR Tier 2, Table 2.7.5-3, “Fire Water Distribution System ITAAC,” Item 4.4 requires an inspection report to document that the as-built fire water distribution system is consistent with the post-fire safe-shutdown analysis. FSAR Tier 2, Table 2.7.5-3, Item 7.1 states that as-build capacity of the fire water storage tanks will be performed to ensure each tank’s capacity is greater than or equal to 1,135,624 l (300,000 gal). FSAR Tier 2, Table 2.7.5-3, Item 7.2 requires inspection to verify at least one electric motor-driven and one diesel engine-driven pump exists and an analysis report that concludes a sufficient number of pumps exist to provide 100 percent capacity assuming failure of the largest pump or loss of offsite power. FSAR Tier 2, Table 2.7.5-3, Item 7.3 requires that testing is done to ensure that the FWDS pumps have sufficient net positive suction head. FSAR Tier 2, Table 2.7.5-3, Item 7.5 requires a flow test line that allows testing of each FWDS pump during plant operation. FSAR Tier 2, Table 2.7.5-3 requires containment isolation valves listed in FSAR Tier 2, Table 2.7.5-1 close within 60 seconds following initiation of a containment isolation signal. FSAR Tier 2,Table 2.7.5-3, Item 7.7 requires an analysis to demonstrate the FWDS will remain functional following a SSE and is capable of supplying the two hydraulically most remote hose stations with at least 284 lpm (75gpm) per hose stream. FSAR Tier 2, Table 2.7.6-1, “Gaseous Fire Extinguishing System ITAAC,” Item 3.4 requires an inspection report to document that the as-built gaseous fire extinguishing system is consistent with the post-fire safe-shutdown analysis. FSAR Tier 2, Table 2.7.6-1, Item 4.1 requires testing and analysis to verify that the gaseous fire extinguishing system will deliver the concentration of suppression agent required to extinguish a fire for the specific suppression agent selected within 10 minutes. FSAR Tier 2, Table 2.7.6-1, Item 4.2 requires testing/analysis to verify that the GFES will maintain the required suppressant agent concentration for the required soak time of 15 minutes.

The staff reviewed the above ITACC and summarizes the significant issues below:

The staff reviewed FSAR Tier 2, Revision 2, Tables 2.1.1-10, 2.1.1-11, 2.1.2-3, and 2.1.5-3 for the mitigation of the propagation of smoke. The staff finds that ITACC exist whose acceptance criteria verify the completion of a fire protection analysis that indicates the presence of barriers, doors, dampers, and penetrations providing separation that mitigate the propagation of smoke to the extent that safe shutdown is not adversely affected as required by SECY 90-016. ITACC have been developed for the NI structures that separate the four Safeguard Buildings, NI structures that provide internal separation between independent divisions within the FB and that separates the FB from other NI structures, EPGB structures that contain the internal hazards within the EPGB of hazard origination, and ESWB structures that contain the internal hazards within the ESWB of hazard origination. The staff finds these ITACC acceptable since they demonstrate the mitigation of the propagation of smoke in areas that could adversely affect safe shutdown.

The staff reviewed FSAR Tier 2, Revision 2, Table 2.7.5-3 and finds an ITAAC exists that verifies that the fire protection standpipe systems and hose systems in areas containing safety-related SSCs including the water supply to these standpipes remain functional and supplying two hose stations at least 284 lpm (75 gpm) per hose stream following an SSE. The staff finds this ITAAC acceptable since it demonstrates that components that need to remain functional after a SSE remain functional

The staff reviewed FSAR Tier 1, Revision 2, Tables 2.1.1-8, 2.1.1-10, and 2.1.1-11 and find that ITAAC exist that verifies the completion of the post-fire safe shutdown analysis that indicates at least one success path comprised of the minimum set of SSCs is available for safe shutdown for the RBA, Safeguard Buildings, and the FB and finds this acceptable since the above ITAAC acceptance criteria are in accordance with RG 1.189, except for the RCB which does not have an ITAAC. (See RAI 482, Question 09.05.01-84 below for details.)

The staff reviewed FSAR Tier 1, Revision 2, Tables 2.1.2-3 and 2.1.5-3 and finds that the Essential Service Water Buildings and the Emergency Power Generator Buildings do not have an ITACC that verifies the completion of the post-fire safe shutdown analysis that indicates at least one success path comprised of the minimum set of SSCs is available for safe shutdown. The staff finds this acceptable for the Essential Service Water Buildings since the four divisional buildings are all separate from each other and from the rest of the plant and, therefore, safe-shutdown is uncomplicated resulting in a low safety significance and does not require an ITACC. The staff finds this acceptable for the Emergency Power Generator Buildings since: (1) each structure houses two diesel generators, two fuel oil tanks, two control rooms, HVAC equipment, electrical equipment, and miscellaneous equipment associated with the operation of each generator; (2) the two diesel generators are separated by a 3 hour fire rated reinforced concrete wall to protect against internal hazards; and (3) the two fuel oil tanks are separated from the diesel generators by a 3 hour fire rated reinforced concrete wall to protect against internal hazards and, therefore, safe-shutdown is uncomplicated resulting in a low safety significance and does not require an ITACC. Additionally, for any given fire area, multiple success paths may be available, so details of a particular set of SSCs success paths are not provided in Tier 1, however, per the requirements of RG 1.189, Revision 1, Section 5, an associated circuit review that includes consideration of short circuits and breaker coordination is required as part of the post-fire safe shutdown analysis and the staff finds this acceptable since Tier 2 requirements include these considerations.

The staff reviewed FSAR Tier 1, Revision 2, Table 2.4.2-2, “Safety Information and Control System ITAAC,” and FSAR Tier 1, Revision 2, Table 2.4.10-1, “Process Information and Control System ITAAC,” and finds that ITAAC exist for electrical isolation between the RSS and MCR. The staff finds this acceptable since the control of equipment required for safe shutdown is performed using the safety information and control system (SICS) and PICS and since the above ITAAC have adequate acceptance criteria to ensure that electrical separation is satisfied.

The staff reviewed FSAR Tier 2, Revision 2, Tables 2.4.6-2, 2.7.5-3, and 2.7.6-1 and finds that ITAAC exist that document an inspection report that states that the as-built plant fire alarm system, the fire water distribution system, and the gaseous fire extinguishing system are consistent with the post-fire safe shutdown analysis. The staff finds this acceptable since the above ITAAC ensure the as-built plant fire alarm system, the fire water distribution system, and the gaseous fire extinguishing system are consistent with the post-fire safe shutdown analysis.

The staff reviewed FSAR Tier 2, Revision 2, Table 2.7.5-3 and finds that an ITAAC exist that states that analysis reports exist that conclude one diesel and one electric pump provide 100 percent capacity assuming failure of the largest pump or loss of offsite power. The staff finds this acceptable since the above the ITAAC verifies 100 percent pump capacity, assuming failure of the largest pump or loss of offsite power which is in accordance with RG 1.189, Revision 1, Regulatory Position C.3.2.2.

The staff reviewed the need for an ITAAC for combustible liquid spill mitigation barriers such as curbs or walls within a division. The staff finds that an ITAAC is not required for these liquid spills mitigation barriers within a division since the spill will not affect the other division and is, therefore, not safety-significant.

The staff reviewed FSAR Tier 1, Revision 2, Table 2.4.21-2 for ITAAC related to communication for fire events and finds an ITACC exists for the portable wireless communication system and other backup systems between the MCR, RSS, and for areas outside of the MCR and RSS that require communication for safe shutdown. The staff finds this acceptable since ITAAC verify communication is available where operator actions for safe shutdown may be required.

The staff reviewed FSAR Tier 1, Revision 2, Table 2.5.9-1 for ITAAC related to the emergency lights and finds ITACC for illuminating the MCR, RSS, and for areas outside of the MCR and RSS including egress routes from the MCR to the RSS and an ITAAC for emergency light battery packs. The staff finds this acceptable since ITAAC verify illumination for post-fire shutdown activities is in accordance with the design criteria discussed above under, "Emergency Lighting."

The staff reviewed FSAR Tier 1, Revision 2, Table 2.2.1-5 and finds an ITAAC exists for the RCP Lube Oil Collection System that demonstrates by analysis that the oil collection system is designed to withstand a safe-shutdown earthquake, to collect lube oil from leakage sites in the RCP lube oil system and, so that the drain line and collection tank are large enough to accommodate the largest potential oil leak. The staff finds this acceptable with the limited information given in the acceptance criteria since FSAR Tier 2, Revision 2, Sections 9.5.1.6.1 and 5.4.1.2.2 contain the detailed supporting information that is used in combination with the Tier 1 acceptance criteria to satisfy the design criteria given in RG 1.189, Regulatory Position C.7.1.

The staff reviewed FSAR Tier 1. Revision 2, Sections 2.1.1, 2.1.2, and 2.1.5 and FSAR Tier 2, Section 9.5.1 and concludes that divisional separation is safety-significant for the U.S. EPR and that ITAAC are needed to test the closure of dampers between divisions to prevent fire effects spreading from one division to another. The staff finds that the dampers within a division are not safety–significant, since the U.S. EPR design has four safety divisions and the loss of one division from fire effects would not adversely affect safe shutdown, even considering one division out of service for maintenance. Therefore, the staff finds that ITAAC items are not needed for fire dampers within a division.

The staff reviewed FSAR Tier 2, Revision 2, Table 2.1.1-8 and finds that an ITAAC exists for dampers that separate the Reactor Building Annulus (RBA) from the Safeguard Buildings and FB and that they verify closure on receipt of signal. The staff finds this acceptable since the ITAAC verifies that the dampers close between the RBA and adjacent buildings to prevent fire effects spreading from one building to another with possible multiple divisions adversely affected.

The staff reviewed FSAR Tier 1, Revision 2, Tables 2.1.1-10 and 2.1.1-11 and finds that an ITAAC exist for the Safeguard Buildings that verifies dampers that separate the four Safeguard Buildings close on receipt of signal, and for the FB that verifies dampers that separate the FB from the NI structures close on receipt of signal. The staff finds this acceptable since each Safeguard Building contains only one division and therefore; only dampers separating the four Safeguard Buildings need to have an ITAAC. Additionally, the FB divisions are separated by internal NI structures and, therefore, only those dampers that are part of these NI structures need to have an ITAAC. Finally, these Safeguard Buildings and FB applicable dampers are verified to close on receipt of signal which is required to isolate fire effects between divisions.

The staff reviewed FSAR Tier 1, Revision 2, Tables 2.1.2-3 and 2.1.5-3 and finds that the Essential Service Water Buildings and the Emergency Power Generator Buildings do not have an ITACC to verify dampers close. The staff finds this acceptable for the Essential Service Water Buildings since the four divisional buildings are all separate from each other including independent ventilation systems that are not connected to the other buildings. The four divisional buildings are also separate from the rest of the plant; therefore, there are no dampers between the buildings that need to be tested and no ITACC is required. The staff finds this acceptable for the Emergency Power Generator Buildings since: (1) each structure houses two diesel generators, two fuel oil tanks, two control rooms, HVAC equipment that is independent for each generator which is not connected to the other divisions as per FSAR Tier 2 Revision 2, Section 9.4.9, electrical equipment, and miscellaneous equipment associated with the operation of each generator; (2) the two diesel generators are separated by a reinforced concrete wall to protect against internal hazards; and (3) the two fuel oil tanks are separated from the diesel generators by a reinforced concrete wall to protect against internal hazards. Therefore, there are no dampers between the generators that need to be tested and no ITACC is required.

The staff reviewed FSAR Tier 1, Revision 2, Tables 2.1.1-10 and 2.1.1-11 and finds that ITAAC exist that verify barriers, doors, dampers, and penetrations in divisional fire barriers meet the design. The staff finds this acceptable since the as-built configuration of barriers, doors, dampers, and penetrations would be verified to agree with the construction drawing. This ensures that the design is in accordance with the design criteria discussed above under, "Compartmentalization, Fire Areas, and Zones / Passive Fire-Resistive Features."

The staff reviewed FSAR Tier 1, Revision 2, Table 2.7.6-1 and finds that ITAAC exist for the MCR sub-floor area that verify that the GFES will deliver the concentration of suppression agent required to extinguish a fire for the specific suppression agent selected within 10 seconds; that the GFES will maintain the required suppression agent concentration for the required soak time of 15 minutes; and that the as-built GFES system is consistent with the post-fire safe shutdown analysis. The staff finds this acceptable since ITAAC verify adequate gaseous suppression for post-fire shutdown activities in the MCR sub-floor in accordance with the design criteria discussed above under, "Exceptions to SRP 9.5.1 and RG 1.189, Control Room Complex," and since the ITACC are consistent with NFPA 2001 which is referenced by RG 1.189.

The staff reviewed FSAR Tier 1, Revision 2, Table 2.7.5-3 and finds that an ITACC exists that verifies that each of the two fire water storage tank is of greater than or equal to 1,135,624 l (300,000 gal) capacity. The staff finds this acceptable with the limited information given in the acceptance criteria since FSAR Tier 2, Revision 2, Section 9.5.1.2.1 contains the detailed supporting information that is used in combination with the Tier 1 acceptance criteria to satisfy the design criteria given in RG 1.189, Regulatory Position C.3.2.1.

The staff reviewed FSAR Tier 1, Table 2.1.1-8, "Reactor Building ITAAC," and finds the following ITAAC Issues:

- There is no ITAAC identified for the separation of the RCB from the RBA for fire. This ITAAC needs to address a fire protection analysis that includes barriers, doors, dampers, and penetrations separating the RCB from the RBA and internal features of the RCB, an as-built inspection of barriers, doors, dampers, and penetrations separating the RCB from the RBA and of the internal features of the RCB, testing of dampers, and a post-fire safe shutdown analysis that indicates that at least one success path for safe shutdown is available including the internal aspects of the RCB.

Therefore, in RAI 482, Question 09.05.01-84, the staff requested that the applicant develop an ITAAC for the RCB and update FSAR Tier 1, Table 2.1.1-8 as needed or provide the justification for not providing the ITAAC.

- ITAAC No. 2.7 for the separation of the RBA from the Safeguard Buildings and FB does not address the mitigation of the propagation of smoke and it is unclear to the staff if the ITAAC item for post-fire safe shutdown analysis includes internal separation aspects of the RBA and it is unclear if the ITAAC item for fire protection analysis includes internal fire protection features of the RBA.

Additionally, in RAI 482, Question 09.05.01-84, the staff requested that the applicant revise this ITAAC for the separation of the RBA from the Safeguard Buildings and FB and update FSAR Tier, Table 2.1.1-8 as needed or provide the justification for not updating the ITAAC.

In an August 30, 2011, response to RAI 482, Question 09.05.01-84, the applicant stated the following:

> U.S. EPR FSAR Tier 1, Section 2.1.1.1 and Table 2.1.1-8—Reactor Building ITAAC will be revised to address the separation of the Reactor Containment Building (RCB) from the Reactor Building Annulus (RBA) for fire effects, and to address the fire protection analysis within the RBA and internal separation features in the RCB.
>
> ITAAC Items 2.24 and 2.25 will be added to U.S. EPR FSAR Tier 1, Table 2.1.1-8, to address fire protection and separation features within the RBA and RCB, respectively.
>
> ITAAC Item 2.7 in U.S. EPR FSAR Tier 1, Table 2.1.1-8, will be revised to clarify the separation of the RBA from the Safeguard Buildings and Fuel Building, and address fire protection features between the RBA and RCB.
>
> ITAAC Items 2.7 and 2.24 in U.S. EPR FSAR Tier 1, Table 2.1.1-8, will be revised to address the mitigation of the propagation of smoke by requiring that a smoke effects analysis be performed.
>
> ITAAC Item 2.7 in U.S. EPR FSAR Tier 1, Table 2.1.1-8, will be revised to change the phrase "minimum 3-hour fire rating" to "adequate fire rating." The phrase "adequate fire rating" will also be used in the new ITAAC items 2.24 and 2.25, which is consistent with U.S. EPR FSAR Tier 2, Section 9.5.1, which states:
>
> "Train separation in the annulus is provided by three hour rated fire barriers or a combination of spatial separation and defense-in-depth fire protection features such as fire barriers, fire rated cable, fire detection, fire suppression, and administrative controls to prevent storage of transient combustibles in the annulus. The containment contains all four divisions of electrical equipment and cabling. Train separation is provided by a combination of spatial separation, physical barriers, and defense-in-depth fire protection features such as fire detection and suppression systems. Fire protection for redundant divisions is provided to provide reasonable assurance that one success path of SSC necessary to achieve safe shutdown conditions (i.e., cold shutdown) is free of fire damage. To comply with the criteria of RG 1.189, separation inside the RB is based on separation as previously described or separation of cables and equipment and associated non-safety-related circuits of redundant success paths is provided by a noncombustible radiant energy shield having a minimum fire rating of 30 minutes."

Therefore, adequate separation is provided by a combination of other fire protection methods other than three-hour fire-rated barriers.

The following U.S. EPR FSAR Tier 2 items will be revised to address the separation of the RCB from the RBA for fire effects, address the fire protection analysis within the RBA and address the mitigation of smoke within the RBA:

Section 9A.3.1

Table 9A-2—Fire Area Parameters

Figure 9A-40—Fire Zone Layouts-Reactor Building, -20 Feet

Figure 9A-41—Fire Zone Layouts-Reactor Building, -8 Feet

Figure 9A-42—Fire Zone Layouts-Reactor Building, +5 Feet

Figure 9A-43—Fire Zone Layouts-Reactor Building, +17 Feet

Figure 9A-44—Fire Zone Layouts-Reactor Building, +29 Feet

Figure 9A-45—Fire Zone Layouts-Reactor Building, +45 Feet

Figure 9A-46—Fire Zone Layouts-Reactor Building, +64 Feet

Figure 9A-47—Fire Zone Layouts-Reactor Building, +79 Feet

Figure 9A-48—Fire Zone Layouts-Reactor Building, +94 Feet

Figure 9A-49—Fire Zone Layouts-Reactor Building, Section A-A

Figure 9A-50—Fire Zone Layouts-Reactor Building, Section B-B

Figure 9A-51—Fire Zone Layouts-Reactor Building, Section C-C

The staff reviewed the proposed FSAR revisions to revise EPR FSAR Tier 1, Section 2.1.1.1 and Table 2.1.1-8 and EPR FSAR Tier 2, Section 9A.3.1, Table 9A-2, and Figures 9A-40 through 51 and finds the above response acceptable except as shown below for RAI 519 Question 09.05.01-88 since the sections, tables, and figures above have been adequately revised to address RCB and RBA separation, RCB internal separation, RBA internal separation, RBA and Safeguards Buildings separation, and RBA and Fuel Building separation for fire protection features such as barriers, doors, dampers, and penetrations, post-fire safe-shutdown, and smoke effects. The staff also finds that having the RBA and RCB walls are 3 hour rated as per Figure 9A-49 and that internal separation uses a defense-in-depth approach of spatial separation, fire barriers, fire rated cable, fire detection, and fire suppression which is acceptable since it is in accordance with RG 1.189 except as noted below in RAI 519, Question 09.05.01-88. **RAI 482, Question 09.05.01-84 is being tracked as a confirmatory item.**

In RAI 519, Question 09.05.01-88, the staff requested the applicant's response to the following: The response to RAI 482 Question 09.05.01-84, revised FSAR Tier 1 Section 2.1.1.1 and Table 2.1.1-8 to delete the 3 hour rated fire barrier separation between the RBA and the SBs and the FB and between the RBA and the RCB, FSAR Tier 2 Appendix 9A tables shows these barriers as 3 hour rated. FSAR Tier 1 Section 2.1.1.1 and Table 2.1.1-8 both reference FSAR Tier 1

Figure 2.1.1-20 for fire ratings but this figure does not designate any fire ratings. Additionally, RG 1.189 Regulatory Position 6.1.1, containment separation criteria only applies internally to the Containment, not between external structures. The applicant needs revise FSAR Tier 1 Section 2.1.1.1 and Table 2.1.1-8 to provide the fire barrier ratings for the above structures or reference a figure that has the ratings and to ensure RG 1.189 Containment separation guidance is used properly. **RAI 519, Question 09.05.01-88 is being tracked as an open item.**

The staff reviewed the remaining descriptive and other information provided in FSAR Tier 1 Revision 2, Fire Protection ITAAC, described above and finds they are consistent with the FPP design basis as described in FSAR Tier 2, Revision 2, Section 9.5.1. Accordingly, the staff finds that the FPP ITAACs comply with the requirements of 10 CFR 52.47(b)(1), except as discussed above in RAI 482, Question 09.05.01-84 and **RAI 519, Question 09.05.01-88**.

9.5.1.5 *Combined License Information Items*

FSAR Tier 2, Revision 2, Table 9.5.1-1, "Fire Protection Program Compliance with Regulatory Guide 1.189," and FSAR Tier 2, Table 1.8-2, "U.S. EPR Combined License Information Items," list the following fire protection COL Information Items:

Table 9.5.1-1 U.S. EPR Combined License Information Items

Item No.	Description	FSAR Tier 2 Section
9.5-2	A COL applicant that references the U.S. EPR design certification will submit site-specific information to address the Regulatory Guide 1.189, Regulatory Position C.1.7.1, Design and Procurement Document Control.	Table 9.5-1 C.1.7.1
9.5-3	A COL applicant that references the U.S. EPR design certification will submit site-specific information to address the Regulatory Guide 1.189, Regulatory Position C.1.7.2, Instructions, Procedures and Drawings.	Table 9.5-1 C.1.7.2
9.5-4	A COL applicant that references the U.S. EPR design certification will submit site-specific information to address the Regulatory Guide 1.189, Regulatory Position C.1.7.3, Control of Purchased Material, Equipment, and Services.	Table 9.5-1 C.1.7.3
9.5-5	A COL applicant that references the U.S. EPR design certification will submit site-specific information to address the Regulatory Guide 1.189, Regulatory Position C.1.8, Fire Protection Program Changes/Code Deviations.	Table 9.5-1 C.1.8
9.5-6	A COL applicant that references the U.S. EPR design certification will submit site-specific information to address the Regulatory Guide 1.189, Regulatory Position C.1.8.1, Change Evaluations.	Table 9.5-1 C.1.8.1
9.5-7	A COL applicant that references the U.S. EPR design certification will submit site-specific information to address the Regulatory Guide 1.189, Regulatory Position C.1.8.5, 10 CFR 50.72 Notification and 10 CFR 50.73 Reporting.	Table 9.5-1 C.1.8.5

Item No.	Description	FSAR Tier 2 Section
9.5-8	A COL applicant that references the U.S. EPR design certification will submit site-specific information to address the Regulatory Guide 1.189, Regulatory Position C.1.8.7, Fire Modeling.	Table 9.5-1 C.1.8.7
9.5-9	A COL applicant that references the U.S. EPR design certification will submit site-specific information to address the Regulatory Guide 1.189, Regulatory Position C.5.5, Post-Fire Safe-Shutdown Procedures.	Table 9.5-1 C.5.5
9.5-10	9.5-10 A COL applicant that references the U.S. EPR design certification will submit site-specific information to address the Regulatory Guide 1.189, Regulatory Position C.5.5.1, Safe Shutdown Procedures.	Table 9.5-1 C.5.5.1
9.5-11	A COL applicant that references the U.S. EPR design certification will submit site-specific information to address the Regulatory Guide 1.189, Regulatory Position C.5.5.2, Alternative/Dedicated Shutdown Procedures.	Table 9.5-1 C.5.5.2
9.5-12	A COL applicant that references the U.S. EPR design certification will submit site-specific information to address the Regulatory Guide 1.189, Regulatory Position C.5.5.3, Repair Procedures.	Table 9.5-1 C.5.5.3
9.5-13	A COL applicant that references the U.S. EPR design certification will submit site-specific information to address the Regulatory Guide 1.189, Regulatory Position C.6.2.4, Independent Spent Fuel Storage Areas.	Table 9.5-1 C.6.2.4
9.5-14	A COL applicant that references the U.S. EPR design certification will submit site-specific information to address the Regulatory Guide 1.189, Regulatory Position C.6.2.6, Cooling Towers.	Table 9.5-1 C.6.2.6
9.5-15	A COL applicant that references the U.S. EPR design certification will submit site-specific information to address Regulatory Guide 1.189, Regulatory Position C.7.6, Nearby Facilities.	Table 9.5-1 C.7.6
9.5-16	A COL applicant that references the U.S. EPR design certification will perform an as-built, post-fire Safe Shutdown Analysis, which includes final plant cable routing, fire barrier ratings, purchased equipment, equipment arrangement and includes a review against the assumptions and requirements contained in the Fire Protection Analysis. The post-fire Safe Shutdown Analysis will demonstrate that safe shutdown performance objectives are met prior to fuel loading and will include a post-fire safe shutdown circuit analysis based on the methodology described in NEI 00-01, "Guidance for Post-Fire Safe-Shutdown Circuit Analysis."	9.5.1.2.1

Item No.	Description	FSAR Tier 2 Section
9.5-17	A COL applicant that references the U.S. EPR design certification will evaluate the differences between the as-designed and as-built plant configuration to confirm the Fire Protection Analysis remains bounding. This evaluation will be performed prior to fuel loading and will consider the final plant cable routing, fire barrier ratings, combustible loading, ignition sources, purchased equipment, equipment arrangement and includes a review against the assumptions and requirements contained in the Fire Protection Analysis. The applicant will describe how this as-built evaluation will be performed and documented, and how the NRC will be made aware of deviations from the FSAR, if any.	9.5.1.3
9.5-18	A COL applicant that references the U.S. EPR design certification will perform a supplemental Fire Protection Analysis for site-specific areas of the plant not analyzed by the FSAR.	9.5.1.3
9.5-19	A COL applicant that references the U.S. EPR design certification will provide a description and simplified Fire Protection System piping and instrumentation diagrams for site-specific systems.	9.5.2.1
9.5-20	A COL applicant that references the U.S. EPR design certification will describe the program used to monitor and maintain an acceptable level of quality in the fire protection system freshwater storage tanks.	9.5.1.2.1

9.5.1.6 *Conclusions*

The staff concludes that the FPP design criteria and the commitments for their implementation as described in the FSAR are acceptable and meet the applicable requirements of 10 CFR 50.48, “Fire Protection,” GDC 3, 10 CFR Part 50, 10 CFR Part 52, “Licenses, Certifications, and Approvals for Nuclear Power Plants,” as well as other acceptance criteria identified in Section 9.5.1.3 of this report, and are consistent with NRC policy contained in SECY-90-016 except as described above. The staff bases this conclusion on the applicant meeting the guidelines of the applicable RGs and related industry standards as described in the FSAR and as discussed in this report except as described in the above open Items.

By meeting these guidelines, except as described above, the applicant’s FPP provides reasonable assurance that safe shutdown can be achieved; assuming that all equipment in any one fire area (excluding the control room and reactor containment) will be rendered inoperable by fire and that re-entry into the fire area for repairs and operator actions is not possible. The applicant’s design provides an independent alternative shutdown capability that is physically and electrically independent of the control room. The applicant’s design provides fire protection for redundant shutdown systems in the Reactor Containment Building that will ensure, to the extent practicable, that one shutdown division will be free of fire damage. Additionally, the applicant’s design provides reasonable assurance that smoke, hot gases, or the fire suppressant will not migrate into other fire areas to the extent that they could adversely affect safe-shutdown capabilities, including operator actions except as described below.

The U.S. EPR design includes specific exceptions to the overall FPP design bases for the U.S. EPR, as well as specific exceptions and alternatives to the NRC acceptance criteria for FPPs. FSAR Tier 2, Revision 2, including proposed revisions, Section 9.5.1.2.2 describes Fire Areas, MCR complex (MCR Peripheral Rooms and MCR sub-floor), Electrical Cable System Fire detection and Suppression, Electrical Cabinets, Cable Design, Cable Spreading room (Cable Floor Area), Switchgear Rooms, fire stops, and Suppression Systems Inside Containment exceptions and alternatives with justification for each of the plant configurations and designs that deviate from the FPP design bases and/or deviate from the NRC acceptance criteria for FPPs. FSAR Tier 2, Revision 2 including proposed revisions, FSAR Tier 2, Table 9.5.1-1 also briefly describes compliance with RG 1.189. The staff reviewed each of these exceptions and alternative approaches and provided justification in above in the section, "Exceptions to SRP 9.5.1 and RG 1.189," of this report.

The COL applicant's satisfactory completion and description of the action items identified above in this report in the section, "Combined License Information items," will provide the staff with sufficient information to assess the acceptability of the FPP for a COL. As described in RG 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)," applicants should include the implementation milestones for programmatic aspects of the FPP in the COL within the license condition on operational program implementation.

9.5.2 Communication Systems

9.5.2.1 *Introduction*

The communication system (COMS) provides reliable and effective communications inside buildings (intra-plant), between buildings (inter-plant), and with external locations (plant-to-offsite) during normal operation, maintenance, transient, fire, accident conditions including loss of offsite power (LOOP) and security-related events.

The U.S. EPR COMS consists of the following subsystems:

- Portable wireless communication system
- Digital telephone system
- Public address and alarm system
- Sound-powered system
- Emergency offsite communication
- Security communication

9.5.2.2 *Summary of Application*

FSAR Tier 1: The FSAR Tier 1 information associated with this section is found in Tier 1, Section 2.4.21, "Communication System."

FSAR Tier 2: The applicant provided FSAR Tier 2 system description in Section 9.5.2, summarized here, in part, as follows:

The COMS provides plant-wide coverage for onsite or internal communications. The capability to initiate external communications to key local and federal entities is provided from the main control room and the remote shutdown station (RSS). The COMS also provides communication capabilities for security personnel.

The base station equipment such as radio transceivers, digital telephone channel banks, and switches of each subsystem are located in a Seismic Category Criteria I structure in separate rooms to avoid losing multiple communication capabilities during an accident or fire. The sound-powered system is distributed throughout the plant and does not require base station-type equipment. The emergency offsite communication interface system and security communication systems have equipment cabinets housing their dedicated telecommunication trunks, as well as dedicated radio equipment, located in an alternate secured location within the Safeguard or Nuclear Island Buildings.

ITAAC: The ITAAC associated with FSAR Tier 2, Section 9.5.2 are given in FSAR Tier 1, Table 2.4.21-2, "The Communication System ITAAC."

Technical Specifications: There are no Technical Specifications associated with FSAR Tier 2, Section 9.5.2.

9.5.2.3 *Regulatory Basis*

The relevant requirements of NRC regulations for this area of review, and the associated acceptance criteria, are given in NUREG-0800, Section 9.5.2 and are summarized below. Review interfaces with other Standard Review Plan (SRP) sections also can be found in NUREG-0800, Section 9.5.2.

Requirements applicable to communications systems are as follows:

1. GDC 1, as it relates to the design, fabrication, erection, and testing of SSCs to quality standards commensurate with the importance of the safety functions to be performed.

2. GDC 2, as it relates to the design of SSCs to withstand the effects of natural phenomena.

3. GDC 3, as it relates to protection of SSCs from the effects of fires and explosions.

4. GDC 4, as it relates to the design of SSCs to accommodate the effects of and to be compatible with the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents, including loss-of-coolant accidents.

5. GDC 19 as it relates to the provision of a control room from which actions can be taken to operate the nuclear power unit safely under normal conditions and to maintain it in a safe condition under accident conditions.

6. 10 CFR Part 50, Appendix E, "Emergency Planning and Preparedness for Production and Utilization Facilities," particularly Part IV.E(9), as it relates to the provision of at least one onsite and one offsite communications system, each with a backup power source

and Part IV.D(1), as it relates to physical means for notifying local, State, and Federal officials and agencies.

7. 10 CFR 50.34(f)(2)(xxv), “Additional TMI-related requirements,” as it relates to the provision of an onsite Technical Support Center, and onsite Operational Support Center.

8. 10 CFR 50.47(b)(8), “Emergency Plans,” as it relates to the provision and maintenance of adequate emergency facilities and equipment to support emergency response.

9. 10 CFR 50.55a, “Codes and Standards,” as it relates to conformance to quality standards, ASME Codes and IEEE standards, and alternatives.

10. 10 CFR 73.45(e)(2)(iii), “Performance Capabilities for Fixed Site Physical Protection Systems,” as it relates to requirements for the communications subsystems and procedures to provide for notification of an attempted unauthorized or unconfirmed removal.

11. 10 CFR 73.45(g)(4)(i), as it relates to requirements for the communications networks to transmit rapid and accurate security information among onsite forces for routine security operation, assessment of a contingency, and response to a contingency.

12. 10 CFR 73.46(f), “Fixed Site Physical Protection Systems, Subsystems, Components, and Procedures − Communications Subsystems,” as it relates to requiring communications subsystems to have provisions to allow continuous communication between each guard, watchman, or armed response individual on duty such that they are able to call for assistance from other guards, watchmen, and armed response personnel and from law enforcement authorities.

13. 10 CFR 73.55(e), “Requirements for Physical Protection of Licensed Activities in Nuclear Power Reactors Against Radiological Sabotage - Physical Barriers,” as it relates provision of physical barriers.

14. 10 CFR 73.55(j), “Communications Requirements,” as it relates to requirements for licensees to establish and maintain continuous communication capability with onsite and offsite resources to ensure effective command and control during both normal and emergency situations.

15. 10 CFR 52.47(b)(1), as it relates to the requirement that a design certification application contain the proposed ITAAC that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a plant that incorporates the design certification is built and will operate in accordance with the design certification, the provisions of the Atomic Energy Act of 1954, and NRC regulations.

Acceptance criteria adequate to meet the above requirements are shown below:

1. Regulatory Guide (RG) 1.189, as it relates to communications systems to support fire protection of nuclear power plants.

2. NRC Bulletin 80-15, “Possible Loss of Emergency Notification System (ENS) with Loss of Offsite Power,” as it relates to provision of backup power for the ENS.

3. IEEE Std 384-1992, "IEEE Standard Criteria for Independence of Class 1E Equipment and Circuits – Description," as it relates to independence and isolation of Class 1E from non-Class 1E systems.

4. IEEE Std 603-1991, "IEEE Standard Criteria for Safety Systems for Nuclear Power Generating Stations – Description," as it relates to design of safety systems.

9.5.2.4 *Technical Evaluation*

9.5.2.4.1 System Description

The communication subsystems described in this section are classified as non-safety-related.

Each communication subsystem provides an independent mode of communications. A failure of one subsystem does not affect the capability to communicate via the other subsystem. These diverse communications systems are independent of each other to provide effective communications, including usage in areas exposed to high ambient noise in the plant.

9.5.2.4.1.1 *Portable Wireless Communication System*

The portable wireless communication system is designed to provide a stand-alone method of communication between designated personnel equipped with, or having access to, wireless two way radios. The radio equipment enables interface to the PA system, as well as to the digital telephone system. The portable radios can dial the digital telephone terminal extensions directly, access a paging channel, or dial to external telephone numbers via an interconnection to the public switched telephone network (PSTN).

The portable wireless communication system is comprised of transmitters, receivers, antennas, amplifiers, and radio base station equipment. The base station equipment for the portable wireless communication system is housed in National Electrical Manufacturers Association (NEMA) 250 Type 4 rated cabinets, which are physically separated from the other subsystems equipment such as the digital telephone, PA, and alarm systems. Repeaters are utilized to allow seamless radio coverage throughout the plant. Antennas and cables interconnecting the repeaters to the base station equipment are located in a manner to facilitate the improved radio signal penetration into areas that are not properly served by the primary antenna. In accordance with RG 1.189, "Fire Protection for Nuclear Power Plants," the repeaters are protected from exposure to fire damage. The COMS system is designed, installed, and tested so that Instrumentation and Control (I&C) system circuits are not adversely impacted by electromagnetic interference/radio frequency interference from transmitting sources. The portable wireless communication system has adequate number of channels to accommodate anticipated functions such as fire, operations, health physics, fuel reloading, emergency, and security.

9.5.2.4.1.2 *Digital Telephone System*

The digital telephone system provides plant-wide intercom capability for private conversation between personnel via private automatic branch exchange (PABX). The digital telephone system also provides an interconnection to the PSTN, allowing incoming and outgoing offsite communication. Dedicated digital telephone terminals are placed throughout the plant to facilitate access to this mode of communication. This system has access to the PA system, enabling personnel the ability to initiate pages over the PA system loudspeakers.

The PABX is equipped with a direct current (dc) power unit and connected to a rectifier/charger and battery system having 2 hours of backup battery capacity. The rectifier/charger unit has sufficient rating to concurrently power a fully equipped PABX system and simultaneously provide charging current to the battery. The charging current requirement is based on a fully discharged battery being recharged to 100 percent over a 12-hour period. Maintenance-free, sealed batteries are used.

9.5.2.4.1.3 *Public Address and Alarm System*

The PA and alarm system facilitate broadcast of messages, sirens, or tones to plant personnel via the paging feature. Non-broadcast communication capabilities are provided via dedicated access terminals that allow one-to-one conversation between parties. The entire plant is reachable via the PA system. It is possible to manually initiate whole-plant alarms or alarms just for specific buildings at the control panel in the MCR and at the RSS.

The PA system utilizes amplifiers, loudspeakers, tone generators, sirens, and party-line access terminals and transceiver equipment to supply verbal and alarm signal communication throughout the entire plant. The PA system utilizes two modes of verbal operation: voice paging and party-line. The PA system also utilizes one mode of non-verbal operation: siren/tone signaling.

9.5.2.4.1.4 *Sound-Powered System*

A sound-powered system, independent from the other COMS subsystems, is provided for normal and abnormal, and accident conditions. This system allows uninterrupted communication between the MCR and the control rod drive equipment areas, refueling platform area, turbine generator operating deck, areas containing switchgear, motor control centers, and other maintenance areas. The sound-powered system provides party-line communication between designated areas by the use of corded headsets or handsets that are plugged into dedicated phone jacks throughout the facility. The sound-powered system does not require an external power source.

9.5.2.4.1.5 *Emergency Offsite Communication*

The offsite communication consists of at least two independent communication subsystems to provide communication links from the Emergency Operation Facility (EOF) to the onsite MCR and Technical Support Center (TSC), as well as to the NRC and other Federal, State, and local government agencies. A backup power source is provided for the offsite communications system.

Space suitable for a TSC, is provided within the integrated operations area adjacent to the MCR. This space is within the Safeguard Building. It is also within the control room envelope (CRE) which maintains habitability during normal, off-normal, and emergency conditions.

Voice communications between the TSC and the plant, local and offsite emergency response facilities, local and State governments, and the NRC are provided by the plant telephone, paging, and radio systems. Data communications within the TSC is provided through the process information and control system (PICS). This non-safety-related digital I&C system provides a screen-based interface capable of monitoring plant parameters during: normal, off-normal, and emergency conditions. It electronically provides MCR safety parameter information to the TSC and to the NRC through the emergency response data system (ERDS).

Space suitable for an Operational Support Center (OSC), is provided within the Access Building. This building also contains a personnel decontamination area. Voice communications in these facilities is provided by the plant telephone, paging, and radio systems.

9.5.2.4.1.6 *System Operation Communications Stations*

Various communication stations are provided throughout the plant. Table 9.5.2-1, "Communication Equipment and Locations," lists the minimum communications stations. The COL applicant referencing the U.S. EPR certified design will identify additional site-specific communication locations necessary to support effective communication between plant personnel in all vital areas of the plant during normal operation, as well as during accident conditions. This is COL Information Item 9.5-1 in FSAR Tier 2, Table 1.8-2.

9.5.2.4.1.7 *Security Communications System*

The security communications system is addressed in FSAR Tier 2, Section 13.6, "Security." The evaluation of the security communications systems will be completed as part of the review of Section 13.6.

9.5.2.4.2 10 CFR Part 50, Appendix E, "Emergency Planning and Preparedness for Production and Utilization Facilities"

9.5.2.4.2.1 *10 CFR Part 50, Appendix E, Part IV.E(9)*

10 CFR Part 50, Appendix E, Part IV.E(9) requires that emergency facilities and equipment include at least one onsite and one offsite communications system with each system having a backup power source. The portable wireless system, PA and alarm system, digital telephone system, and sound-powered system provide onsite communications.

<u>Onsite communication subsystems</u>

The onsite communication subsystems are powered from the onsite Class 1E emergency uninterruptible power supply (EUPS), which is supported by the emergency and station blackout (SBO) diesel generators to provide backup power. An isolation device is placed between the non-Class 1E COMS system and the Class 1E power supply to provide the required independence per IEEE Std 384-1992. FSAR Tier 1, Section 9.5.2.1 states that non-Class 1E COMS subsystems that are powered from Class 1E power sources are isolated by a single Class 1E circuit breaker or fuse. 10 CFR 50.55a(h) incorporates by reference IEEE Std 603-1991. The adequacy of this isolation device as required by IEEE Std 603-1991, Clause 5.6.3 is demonstrated as follows:

- IEEE Std 603-1991, Clause 5.6.3.1 is met by the following:
    - The isolation device is classified as part of the safety system (Class 1E power system). The isolation device will be qualified to Class 1E standards.
    - The circuit breaker or fuse used for this isolation is applied so that the maximum credible voltage or current transient applied to the non-Class 1E side of the circuit breaker or fuse does not degrade below an acceptable level the operation of the circuit on the other side of that circuit breaker or fuse, in accordance with IEEE Std 384-1992.

- IEEE Std 603-1991, Clause 5.6.3.2 is met by the following:

  Following the isolation device, the COMS power circuit is treated as an 'associated circuit' and routed with the division from which it originated, or it remains separated from the Class 1E circuit. The separation of Class 1E equipment shall be in accordance with IEEE Std 384-1992.

- IEEE Std 603-1991, Clause 5.6.3.3 is met by the following:

  Isolation of the communication systems from Class 1E power systems prevents degrading the Class 1E power source below an acceptable level.

The staff finds the information provided in FSAR Tier 1, Section 9.5.2.1 meets the requirements of IEEE Std 603-1991, Clause 5.6.3 by providing electrical isolation between safety and non-safety systems. Specifically, the staff finds the qualification of the isolation device to meet IEEE Std 603-1991, Class 1E standards and the application of the maximum credible voltage or current transient to the non-safety side of the circuit breaker will verify that a failure from the non-safety side will not propagate to the Class 1E power system.

Emergency offsite communication system

Offsite communication consists of at least two independent communication subsystems to provide emergency communication links from the Emergency Operation Facility (EOF) to the onsite MCR and TSC as well as to the NRC and other Federal, State, and local government agencies. A backup power source is provided for the offsite communication systems. FSAR Tier 2, Section 9.5.2.2.5 states that to facilitate two-way (incoming and outgoing) emergency communications from onsite to offsite facilities/agencies, at least two independent communication links are provided. The onsite facilities provided with the emergency communication links are the MCR, RSS, TSC, and Operations Support Center. The offsite facilities that are considered are the Emergency Operations Facility, NRC resident office and Federal, State, and local government agencies identified in the emergency response plan, to be addressed by the COL applicant (as identified in COL Item 13.3-1). The two independent communication links are as follows:

1. Dedicated "hotline" telephones that provide direct communications to the selected locations when in an off-hook condition. The provisions for "hotline" telephones are incorporated into the design of the onsite digital telephone subsystem.

2. Provisions for two-way radio communications via the portable wireless communication subsystem for personnel having access to specific wireless radios onsite and for the offsite personnel as required by the COL applicant.

In addition, the onsite digital telephone subsystem has interconnectivity via PABX to the public switched telephone network (PSTN) which allows incoming and outgoing offsite communications. The onsite portable wireless communication (radio) subsystem has an interface to the onsite PA and alarm subsystem as well as to the digital telephone subsystem via PABX. Also, the onsite digital telephone subsystem has an interface to the PA and alarm subsystem. Testing of the offsite communications system is addressed by existing COL Items 13.3-1 and 14.3-1.

In addition, the staff finds COL Information Item 14.3-1, which states, "a COL applicant that references the U.S. EPR design certification will provide ITAAC for emergency planning, physical security, and site-specific portions of the facility that are not included in the Tier 1 ITAAC associated with the certified design (10 CFR 52.80(a))," adequately ensures testing of the onsite and offsite communications equipment.

NRC Bulletin 80-15 provides guidance for the licensees to address Emergency Notification System (ENS) backup power requirements in case of loss-of-offsite power. Therefore, in RAI 36, Question 09.05.02-8, the staff requested that the applicant identify the backup power source in case of loss of offsite power. In a September 11, 2008, response to RAI 36, Question 09.05.02-8, the applicant stated that the ENS is implemented using the following:

- the onsite communications subsystems described in FSAR Tier 2, Section 9.5.2
- the interface to the emergency offsite communications system
- the emergency offsite communication system

NRC Bulletin 80-15 is addressed by the fact that the onsite communication systems and the interface to the emergency offsite communication system are powered from the Class 1E emergency uninterruptible power supply (EUPS), which is supported by the emergency and station blackout diesel generators to provide a long term backup source of power. The EUPS also allows for the continued operation of the COMS subsystems after a loss of power, since the EUPS supplies a continuous dc backup power for a period of 2 hours. The EUPS is described in FSAR Tier 2, Section 8.3.2.1.1. The power source for the emergency offsite communication system, including backup power, will be addressed by the COL applicant as specified in COL Information Item 9.5-21, which states:

> A COL applicant that references the U.S. EPR design certification will provide a description of the offsite communication system that interfaces with the onsite communication system, including type of connectivity, radio frequency, normal and backup power supplies and plant security system interface.

FSAR Tier 2, Section 9.5.2.1 states that the interface to the emergency offsite communication system is fed by the EUPS to maintain operability during SBO and LOOP conditions. The staff finds the use of onsite Class 1E EUPS, supported by the emergency and SBO diesel generators to provide backup power for the interface to emergency offsite communication systems acceptable in meeting the requirements of 10 CFR Part 50, Appendix E, Part IV.E(9). Additionally, the staff finds COL Item 9.5-21 is adequate to confirm that a description of the power sources, including normal and backup, for emergency offsite communication system are provided by the COL applicant to address NRC Bulletin 80-15.

Backup Power Source

FSAR Tier 2, Section 9.5.2.1.1 states that, with the exception of the sound-powered system, the onsite communications systems have a backup power source (i.e., the emergency and station blackout diesel generators). FSAR Tier 2, Section, 9.5.2.2.4 states that the sound-powered system does not require an external source of power for operation; therefore, the system does not need a backup source of power. The sound-powered phone works on the principle of creating an electrical signal from sound waves. An electro-mechanical transducer in a sound-powered telephone converts sound pressure from a user's voice into electrical current. The electric current is sent through standard telecommunication wiring to the receiver. At the receiving end, the electrical current is converted back to sound energy by the receiving transducer. The phones require no batteries, amplifiers, or power supplies.

The sound-powered phone circuit emits no electromagnetic or radio frequency interference. Several stations (phones) can be connected on the same circuit. The staff finds the description of the sound powered system in FSAR Tier 2, Section 9.5.2.1.1 and the use of the emergency and station blackout diesel generators for backup power demonstrate that the onsite communication subsystems will remain operational if onsite power is not available and, therefore, complies with the requirements of 10 CFR Part 50, Appendix E, Part IV.E(9).

9.5.2.4.2.2 *10 CFR Part 50, Appendix E, Part IV.D (1)*

10 CFR Part 50, Appendix E, Part IV.D(1) requires a description of the administrative and physical means for notifying local, State, and Federal officials and agencies and agreements reached with these officials and agencies for the prompt notification of the public and for public evacuation or other protective measures, should they become necessary. FSAR Tier 2, Section 9.5.2.2.5 states that emergency offsite communication is discussed in FSAR Tier 2, Section 13.3. FSAR Tier 2, Section 13.3 states that a COL applicant that references the U.S. EPR design certification will provide a site-specific emergency plan in accordance with 10 CFR 50.47 and 10 CFR Part 50, Appendix E. In addition, COL Item 9.5-21 requires that the COL applicant provide a description of the offsite communication system that interfaces with the onsite communication system. The staff finds the COL Item 9-21 acceptable in complying with the requirements of 10 CFR Part 50, Appendix E, Part IV.D(1), to provide a description of the administrative and physical means for notifying local, State, and Federal officials and agencies and agreements reached with these officials and agencies for the prompt notification of the public and for public evacuation or other protective measures, should they become necessary.

9.5.2.4.3 10 CFR 50.34 (f)(2)(xxv), "Additional TMI-Related Requirements"

10 CFR 50.34 (f)(2)(xxv) requires licensees to provide an onsite Technical Support Center, an onsite Operational Support Center, and, for construction permit applications only, a nearsite Emergency Operations Facility.

FSAR Tier 2, Section 9.5.2.1.2 that details of the emergency response facilities, including the TSC, OSC, and the EOF, are provided by the COL applicant as addressed in FSAR Tier 2, Section 13.3. As stated in Section 9.5.2.4.3 of this report, the staff had requested the applicant to identify the specific COL information item that requires the COL applicant to address emergency offsite interfaces. The staff finds the proposed addition of COL Information Item 9.5-21, which states that a COL applicant that references the U.S. EPR design certification will provide a description of the offsite communication system that interfaces with the onsite communication system, adequate in response to this request.COL Information Item 9.5.2-1 requires that the COL applicant provide a description of the offsite communication system that interfaces with onsite communication systems. The staff finds COL Information Item 9.5.2-1 acceptable to comply with the requirements of 10 CFR 50.34(f)(2)(xxv).

9.5.2.4.4 10 CFR 50.47(b)(8) "Emergency Plans"

10 CFR 50.47(b)(8) requires that adequate emergency facilities and equipment to support the emergency response are provided and maintained. FSAR Tier 2, Section 9.5.2 states that details of emergency response facilities and associated communication capabilities are provided by the COL applicant as addressed in FSAR Tier 2, Section 13.3. As stated in Section 9.5.2.4.3 of this report, the staff had requested that the applicant identify the specific COL information item that requires the COL applicant to address emergency offsite interfaces. In response to this, the applicant provided COL Information Item 9.5.2-1. Additionally, FSAR Tier 2, Section 9.5.2.2.3 states that the PA system utilizes amplifiers, loudspeakers, tone generators,

sirens, and party-line access terminals and transceiver equipment as a means of supplying verbal and alarm signal communication throughout the entire plant. A tone generator is provided with five warning tones: (1) Pulse; (2) siren; (3) yelp; (4) warble; and (5) steady. Tones are activated by a number of external sources which include fire equipment, or by manually closing user-supplied contact switches. Higher priority tones can be programmed to override those of lower priority.

The staff finds COL Information Item 9.5.2-1, which states, in part, that a COL applicant that references the U.S. EPR design certification will provide a description of the offsite communication system that interfaces with the onsite communication system complies with the requirements of 10 CFR 50.47(b)(8). Specifically, the staff finds that the PA system provides adequate alerting mechanisms to support emergency response.

9.5.2.4.5 10 CFR 50.55a, Codes and Standards

10 CFR 50.55a(1) requires that SSCs must be designed, fabricated, erected, constructed, tested, and inspected to quality standards commensurate with the importance of the safety function to be performed. In addition, FSAR Tier 2, Section 9.5.2.1.4 states that SSCs of the COMS are designed, fabricated erected, constructed, tested, and inspected to quality standards that are required by industry standards. The SSCs are installed in structures and anchored to sustain earthquake or other natural events without causing damage to any Class 1E SSCs that are important to safety. The following codes and standards as applicable are utilized for the COMS design:

- IEEE Std 269-2002, “IEEE Standard Methods for Measuring Transmission Performance of Analog and Digital Telephone Sets, Handsets, and Headsets”
- IEEE Std 487-2000, “IEEE Recommended Practice for the Protection of Wire-Line Communication Facilities Serving Electric Supply Locations”
- IEEE Std 692-1997, “IEEE Standard Criteria for Security Systems for Nuclear Power Generating Stations”
- IEEE Std 1613-2003, “IEEE Standard Environmental and Testing Requirements for Communications Networking Devices in Electric Power Substations”
- NFPA 70-2005, “National Electrical Code (NEC)”
- NFPA 72-2007, “National Fire Alarm Code”
- 29 CFR Part 1910.165, Occupational Safety and Health Standards, “Employee Alarm Systems”
- EPRI TR-102323-R3, “Guidelines for Electromagnetic Interference Testing of Power Plant Equipment”
- MIL-STD-810F, “Environmental Engineering Considerations and Laboratory Tests”
- IEEE/ANSI C63.12-1999, “American National Standard Recommended Practice for Electronic Compatibility Limits”

- ANSI/TIA-603-C-2004, “Land Mobile FM or PM - Communications Equipment - Measurement and Performance Standards”

- IEC 60529-2004, “Degrees of Protection Provided by Enclosures (IP Code)

Based on the commitment to utilize the above codes and standards for the COMS design, the staff finds the application of these codes and standards to the design and testing of the COMS systems has fully addressed 10 CFR 50.55a(1).

9.5.2.4.6 10 CFR Part 50, Appendix A − General Design Criteria

10 CFR Part 50, Appendix A, GDC 1 requires SSCs important to safety to be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed. A quality assurance program shall be established and implemented in order to provide adequate assurance that these SSCs will satisfactorily perform their safety functions. Appropriate records of the design, fabrication, erection, and testing of SSCs important to safety shall be maintained by or under the control of the nuclear power unit licensee throughout the life of the unit.

10 CFR Part 50, Appendix A, GDC 3 requires SSCs important to safety to be designed and located to minimize, consistent with other safety requirements, the probability and effect of fires and explosions. Noncombustible and heat resistant materials shall be used wherever practical throughout the unit, particularly in locations such as the containment and control room.

10 CFR Part 50, Appendix A, GDC 1, GDC 2, GDC 3, and GDC 4 apply to SSCs important to safety. In addition, GDC 19 requires equipment at appropriate locations outside the MCR to be provided for prompt hot shutdown of the reactor with a potential capability for subsequent cold shutdown of the reactor through the use of suitable procedures.

FSAR Tier 2, Section 9.5.2.1.5 classifies the COMS as a non-Class 1E system and, therefore, serves no safety-related functions. While there is COMS equipment located in the RSS, the COMS equipment is not required to function for hot or cold shutdown of the reactor. The staff finds that although the COMS equipment does not serve a safety-related function, it is important to safety, as it provides required communications capability during plant emergencies. Therefore, the staff concludes that the applicant is required to demonstrate how the design of the COMS equipment complies with the requirements of 10 CFR Part 50, Appendix A, GDC 1 and GDC 2. The staff finds the COMS equipment does not serve a function to support prompt hot shutdown of the reactor; therefore, the staff concludes that the COMS equipment does not need to meet the requirements of 10 CFR Part 50, Appendix A, GDC 19.

As stated in Section 9.5.2.5 of this report, the staff finds the application of the list of codes and standards stated in FSAR Tier 2, Section 9.5.2.1.4 acceptable to ensure quality of the design and testing of the COMS systems. As stated in NUREG-0800, Section 9.5.2, typically communication systems will be composed of commercial equipment. As such, the equipment should be appropriately qualified commensurate with the safety performance of the equipment. Qualification can be demonstrated through a quality assurance program as described in 10 CFR Part 50, Appendix B, or through a commercial dedication program in a similar manner to that described in Electric Power Research Institute (EPRI) NP-5652, “Guideline for the Utilization of Commercial-Grade Items in Nuclear Safety-Related Applications,” and EPRI TR-10643*, Guideline on Evaluation and Acceptance of Commercial Grade Digital Equipment for Nuclear Safety Applications.”

In RAI 379, Question 09.05.02-12, the staff requested that the applicant describe the process used to qualify this COMS equipment, to assure a quality product in keeping with the required communications functions to meet the requirements of GDC 1. In an October 6, 2010, response to RAI 379, Question 09.05.02-12, the applicant stated that to verify delivery and installation of a quality product, the supplier is required to have a quality management system (QMS) for the design, manufacture, installation management, and services that incorporate certain aspects of the guidelines and methods provided in EPRI documents NP-5652 and TR-106439. The COMS equipment is appropriately qualified commensurate with the safety significance of the equipment functions. The applicant provided Interim FSAR Revision 3 markups to incorporate this description into the FSAR. The staff finds this response acceptable to comply with the requirements of 10 CFR Part 50, Appendix A, GDC 1, by confirming that all commercial COMS equipment will be build under a QMS in accordance with certain aspects of EPRI NP-5652 and TR-106439. The inclusion of the proposed changes provided in the FSAR markups regarding the commitment to EPRI documents NP-5652 and TR-106439 are in the final submitted FSAR Revision 3. **RAI 379, Question 09.05.02-12 is being tracked as a confirmatory item.**

In addition, FSAR Tier 2, Section 9.5.2 states that base station equipment such as radio transceivers, digital telephone channel banks, and switches of each subsystem are located in a Seismic Category Criteria I structure in separate rooms to avoid losing multiple communication capabilities during an accident or fire. The sound-powered system is distributed throughout the plant and does not require base station-type equipment. The emergency offsite communication interface system and security communication systems have equipment cabinets housing their dedicated telecommunication trunks, as well as dedicated radio equipment, located in an alternate secured location within the Safeguard or NI Buildings. The staff finds that the physical independence of the COMS equipment provides reasonable assurance that the COMS equipment will remain operable during a design-basis event and, therefore, complies with the requirements of 10 CFR Part 50, Appendix A, GDC 2, GDC 3, and GDC 4.

9.5.2.4.7 10 CFR 73.45(g)(4)(i) and 10 CFR 73.45(e)(2)(iii), Performance Capabilities for Fixed Site Physical Protection Systems

10 CFR 73.45(e)(2)(iii), "Performance Capabilities for Fixed Site Physical Protection Systems," requires licensees to provide communications subsystems and procedures to provide for notification of an attempted unauthorized or unconfirmed removal so that response can be such as to prevent the removal and satisfy the general performance objective and requirements of 10 CFR 73.20(a). In addition, 10 CFR 73.45(g)(4)(i) requires the provision of communications networks to transmit rapid and accurate security information among onsite forces for routine security operation, assessment of a contingency, and response to a contingency.

FSAR Tier 2, Section 9.5.2.1.6 states that the COMS provides communication capability for plant security personnel, guards, and watchmen at certain locations as necessary to support the transmission of security information among onsite forces. Additional security communication measures are included as part of the physical protection intercommunication system including the use of private, secure communication radios. The evaluation of the security communications system will be completed in the safety evaluation of FSAR Tier 2, Section 13.6.

9.5.2.4.8 10 CFR 73.55(j), Requirements for Physical Protection of Licensed Activities in Nuclear Power Reactors Against Radiological Sabotage, Communications Requirements, and 10 CFR 73.46(f), Fixed Site Physical Protection Systems, Subsystems, Components and Procedures – Communications Subsystems

10 CFR 73.55(j), "Communication Requirements," requires, in part, the applicant to establish and maintain continuous communication capability with onsite and offsite resources to ensure effective command and control during both normal and emergency situations. In addition, 10 CFR 73.46(f), "Fixed site Physical Protection Systems, Subsystems, Components and Procedures – Communications Subsystems," requires, in part, non-portable communications equipment controlled by the licensee and required by this section to remain operable from independent power sources in the event of the loss of normal power.

FSAR Tier 2, Section 9.5.2.1.7 states that the portable wireless communication system and the digital telephone system enable guards, watchmen, or armed response individuals on duty to maintain continuous communication with individuals in continuously manned alarm stations and with law enforcement authorities, as required by 10 CFR 73.55(j) and 10 CFR 73.46(f). Design features required for security, including alarms and communications required by 10 CFR 73.55, are listed in FSAR Tier 2, Section 13.6. A physical security plan, as addressed in FSAR Tier 2, Section 13.6, is provided by the COL applicant per 10 CFR 52.79(a)(35) that complies with the requirements of 10 CFR Part 73. Non-portable communications equipment required by these regulations are powered from independent power sources so that they remain operable in the event of a loss of normal power. In RAI 36, Question 09.05.02-11, the staff requested that the applicant clarify how the design of the portable wireless communication system and the offsite communication system meet the requirements of 10 CFR 73.46(f)(3) to provide continuous communications for guards, watchmen, or armed response individuals on duty. In a September 11, 2008, response to RAI 36, Question 09.05.02-11, the applicant stated that this is a COL applicant responsibility as covered by the proposed COL Information Item No. 9.5-21. In addition, FSAR Tier 2, Section 9.5.2.1.7 states: "Design features required for security, including alarms and communications required by 10 CFR 73.55, are given in Section 13.6." The evaluation of the security communications system is completed in the safety evaluation of FSAR Tier 2, Section 13.6.

9.5.2.4.9 Inspection and Testing Requirements

10 CFR 52.47(b)(1) requires that a design certification application contain the proposed ITAAC that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met the facility that incorporates the design certification has been constructed and will be operated in conformity with the design certification, the provisions of the Atomic Energy Act of 1954, and NRC rules and regulations.

FSAR Tier 2, Section 9.5.2.4 states that each COMS subsystem is unique and requires specific sets of test procedures for use by the plant operations and maintenance staff. Following construction, modification, repair, or replacement of COMS equipment, sufficient testing is performed to demonstrate that equipment performs satisfactorily in service and that design criteria are met. FSAR Tier 2, Section 14.2.12.11.7, "Communication System (Test No. 130)," describes the initial plant testing to verify the adequacy of intra-plant and offsite communication systems. The staff reviewed FSAR Tier 2, Section 14.2.12.11.7 and finds that the description of initial plant testing requirements sufficiently verifies (1) the functionality of the intra-plant communication system to provide communications between vital plant areas and (2) the functionality of the offsite communication requirements of 10 CFR 52.47(b)(1). Additionally, the staff finds that COL Information Item 14.3.1, which requires that the COL applicant provide an ITAAC for emergency planning, physical security, and site-specific portions of the facility, is adequate to ensure that the COL applicant will verify the offsite communications as designed to Federal, State, and local authorities are acceptable to comply with the requirements of 10 CFR 52.47(b)(1).

9.5.2.4.9.1 *Digital Telephone System Testing Criteria*

FSAR Tier 2, Section 9.5.2.4, “Inspection and Testing Requirements,” states that the digital telephone system is tested in accordance with IEEE Std 269-2002, “IEEE Standard Methods for Measuring Transmission Performance of Analog and Digital Telephone Sets, Handsets, and Headsets –Description,” as a method to verify proper operation of the system. The applicant has provided Interim FSAR Tier 1, Revision 3 markups as part of a June 22, 2011, response to RAI 452, Question 07.03-36. FSAR Tier 1, Table 2.5.12-2, Item 2.1, Interim Revision 3, contains commitments and acceptance criteria to verify the operation and coverage of the COMS equipment. The staff reviewed this and finds this ITAAC acceptable to verify that the digital telephone system operates as designed to meet the requirements of 10 CFR 52.47(b)(1). Specifically, the staff finds the acceptance criteria that (1) the digital telephone system, the public address and alarm system, sound-powered system, and portable wireless communication system exist in the MCR and the location listed in FSAR Tier 2, Interim Revision 3, Table 2.5.12-1 and (2) voice transmission and reception via the digital telephone system and sound-powered system is verified between the MCR and the locations listed in FSAR Tier 2, Interim Revision 3, Table 2.5.12-1 are acceptable and demonstrate the operation and coverage of the digital telephone system. The inclusion of the proposed changes provided in the FSAR markups regarding the COMS ITAAC in the final submitted FSAR Revision 2 is being tracked as a confirmatory item. In Chapter 7 of this report RAI 452, Question 07.03-36 is being tracked as a confirmatory item.

9.5.2.4.9.2 *EMI/RFI Testing Criteria*

10 CFR 52.47(a)(9) requires, in part, that for applications for light-water cooled nuclear power plants, an evaluation of the standard plant design against the SRP revision in effect 6 months before the docket date of the application. The evaluation required by this section shall include an identification and description of all differences in design features, analytical techniques, and procedural measures proposed for the design and those corresponding features, techniques, and measures given in the SRP acceptance criteria. NUREG-0800, Section 9.5.2 states that while non-safety systems are not part of this regulatory guide, control of EMI/RFI from these systems is necessary to ensure that safety-related I&C systems can continue to perform properly in the nuclear power plant environment. When feasible, the emissions from non-safety-related systems should be held to the same levels as those from safety-related systems.

FSAR Tier 2, Section 9.5.2.4 states that the communication equipment is tested in accordance with the procedure recommended by the equipment supplier to verify COMS operability under the predicted worst-case EMI/RFI environment. In addition, FSAR Tier 2, Section 14.2.12.11.7, “Communication System (Test #130),” Subsection 3.0 includes testing for EMI/RFI effects with the following criterion:

> Verify the effectiveness of the exclusion zones established for protecting the safety-related I&C equipment from mis-operation due to EMI/RFI effects from the portable phones and radios of the communication system.

Additionally, FSAR Tier 2, Section 9.5.2.1.4 states that the COMS equipment will be factory tested to verify compliance with the emission limits specified in EPRI TR-102323-R3 for EMI/RFI. The related test requirements included in the standards in the EPRI TR-102323-R3 are specified for the COMS equipment factory testing. Also, the COMS equipment arrangement and layout design is based on the practices recommended in the EPRI guidelines for minimizing susceptibility to EMI and RFI. RG 1.180, "Guidelines for Evaluating Electromagnetic and Radio-Frequency Interference in Safety-Related Instrumentation and Control Systems," states that the staff found EPRI TR-102323 acceptable to address EMI/RFI for safety-related digital I&C systems in nuclear power plants.

Based on the applicant's commitment to conform to EPRI TR-102323-R3, as stated in FSAR Tier 2, Section 9.5.2.1.4 and Initial Test #130, the staff finds the communications subsystem adequately addresses EMI/RFI testing to ensure that safety systems are not adversely impacted due EMI/RFI effects from COMS equipment. Furthermore, the staff finds that an ITAAC is not necessary for EMI/RFI testing, given that the initial test covers this. As such, the staff finds the applicant has adequately addressed the requirements of 10 CFR 52.47(b)(1).

9.5.2.4.9.3 *Wireless Testing Criteria*

FSAR Tier 2, Section 9.5.2.2.1 states that the portable wireless communication system is comprised of transmitters, receivers, antennas, amplifiers, and radio base station equipment. Antennas and amplifiers are distributed throughout the plant to enable seamless radio coverage. In a June 22, 2011, response to RAI 452, Question 07.03-36, the applicant provided FSAR Interim Revision 3 markups. The markups included a revision to the Communications ITAAC. FSAR Tier 1, Table 2.5.12-2, Item 2.1 ITAAC states that the digital telephone system, the public address and alarm system, sound-powered system, and portable wireless communication system provide station-to-station communication and area broadcasting between the MCR and all the locations in FSAR Tier 1, Table 2.5.12-1. The acceptance criteria states that:

- The digital telephone system, the public address and alarm system, sound-powered system, and portable wireless communication system exist in the MCR and the location listed in FSAR Tier 1, Table 2.5.12-1.
- Voice transmission and reception via the digital telephone system and sound-powered system is verified between the MCR and the locations listed in FSAR Tier 1, Table 2.5.12-1.
- The broadcasting of voice messages from the MCR to the locations listed in FSAR Tier 1, Table 2.5.12-1 via the public address and alarm system is verified. Voice transmission and reception via the portable wireless communication system is verified between the MCR and the locations listed in FSAR Tier 1, Table 2.5.12-1.

Based on the commitments to provide a portable wireless communication system provide station-to-station communication and area broadcasting between the MCR and all the locations in FSAR Tier 2, Table 2.5.12-1 and to utilize the acceptance criterion that voice transmission and reception via the portable wireless communication system is verified between the MCR and the locations listed in FSAR Tier 2, Table 2.5.12-1, the staff finds the applicant has adequately addressed the wireless coverage guidance in SRP Section 9.5.2 to comply with the requirements of 10 CFR 52.47(b)(1).

9.5.2.4.9.4 *Maximum Noise Condition Testing Criteria*

10 CFR 52.47(a)(9) requires, in part, for applications for light-water cooled nuclear power plants, an evaluation of the standard plant design against the SRP revision in effect 6 months before the docket date of the application. The evaluation required by this section shall include an identification and description of all differences in design features, analytical techniques, and procedural measures proposed for the design and those corresponding features, techniques, and measures given in the SRP acceptance criteria. NUREG-0800, Section 9.5.2 states that the review should verify that the features to alert personnel in high-noise environments to use the communication systems are adequate.

FSAR Tier 2, Section 9.5.2.4 states that the communications equipment is tested periodically to verify that COMS equipment can operate under maximum plant noise conditions. FSAR Tier 2, Section 14.2.12.11.7, "Communication Subsystems," describes the startup testing for the communications equipment. Test #130, Subsection 3.0 includes testing under maximum potential noise levels as follows:

- Verify that the communication equipment will perform under anticipated maximum plant noise levels.

Additionally, FSAR Tier 2, Section 14.2.12.11.7, includes the following acceptance criterion:

- Safety-related I&C equipment is not adversely impacted by the portable phones and radios of the communication system.

Based on the startup testing of the COMS equipment under maximum plant noise levels and the acceptance criterion to ensure that safety-related equipment is not adversely impacted by the portable phones and radios, the staff finds the startup testing program adequately addresses the criteria for COMS equipment for high-noise environment in SRP Section 9.5.2. Furthermore, the staff finds an ITAAC for noise testing is not necessary, given that the initial test covers this. As such, the staff finds the COMS equipment complies with the requirements of 10 CFR 52.47(b)(1).

9.5.2.4.9.5 *Electrical Isolation Testing Criteria*

As described in Section 9.5.2.4.2.1 of this report, the non-Class 1E COMS subsystems that are powered from Class 1E power sources are isolated by a single Class 1E circuit breaker or fuse. The staff determined that the applicant has not provided an ITAAC to verify that sufficient electrical isolation exists between the COMS equipment and the Class 1E power system to comply with the requirements of 10 CFR 52.47 (b)(1). Therefore, in RAI 379, Question 09.05.02-14, the staff requested that the applicant provide an ITAAC that verifies electric isolation requirements are met. In a September 2, 2010, response to RAI 379, Question 09.05.02-14, the applicant stated that the FSAR Tier 1, Section 2.5.2 and FSAR Tier 2, Table 2.5.2-3, "Class IE Uninterruptible Power Supply," address electrical isolation between the equipment and Class IE power system. FSAR Tier 1, Section 2.5.2, Item 5.2 states, "Non-safety-related loads connected to the EUPS are electrically isolated from the EUPS by an isolation device." The staff finds this response acceptable by verifying that non-safety-related loads, including COMS equipment connected to the EUPS, are electrically isolated from the EUPS by an isolation device. Therefore, the staff finds that the applicant has addressed electrical isolation test criteria in compliance with the requirements of 10 CFR 52.47(b)(1).

9.5.2.5 *Combined License Information Items*

Table 9.5.2-1 provides a list of communications systems related COL information item numbers and descriptions from FSAR Tier 2, Table 1.8-2:

Table 9.5.2-1 U.S. EPR Combined License Information Items

Item No.	Description	FSAR Tier 2 Section
9.5-1	A COL applicant referencing the U.S. EPR certified design will identify additional site-specific communication locations necessary to support effective communication between plant personnel in all vital areas of the plant during normal operation, as well as during accident conditions.	9.5.2.3
9.5-21	A COL applicant that references the U.S. EPR design certification will provide a description of the offsite communication system that interfaces with the onsite communication system.	9.5.2.1.1

The staff finds the above listing to be complete. Also, the list adequately describes actions necessary for the COL applicant or holder. No additional COL information items need to be included in FSAR Tier 2, Table 1.8-2 for communications systems consideration.

9.5.2.6 *Conclusions*

The staff reviewed FSAR Tier 2, Section 9.5.2 communication systems for the U.S. EPR. The staff concludes the following:

Based on the information provided in FSAR Tier 2, Section 9.5.2 regarding onsite and offsite communications systems and their respective normal and backup power sources, the staff finds that the applicant complies with the requirements of 10 CFR Part 50, Appendix E, Part IV.E(9). The staff's evaluation is documented in Section 9.5.2.4.2.1 of this report.

Based on the information provided in the FSAR Tier 2, Section 9.5.2 and COL Information Item 9.5-21, the staff finds the applicant complies with the requirements of 10 CFR Part 50, Appendix E, Part IV.D(1). The staff's evaluation is documented in Section 9.5.2.4.2.2 of this report.

Based on the COL Information Item 9.5-21, which requires that the COL applicant provide a description of the offsite communication system that interfaces with onsite communication systems and the commitments for the COL applicant to provide details of the emergency response facilities in FSAR Tier 2, Section 13.3, the staff concludes that the applicant complies with the requirements of 10 CFR 50.34(f)(2)(xxv). The staff's evaluation is documented in Section 9.5.2.4.3 of this report.

Based on the information provided in the FSAR Tier 2, Section 9.5.2 regarding equipment and facilities to support emergency response, and COL Information Item 9.5-21, the staff concludes that the applicant complies with the requirements of 10 CFR 50.47(b)(8). The staff's evaluation is documented in Section 9.5.2.4.4 of this report.

Based on the information provided in the FSAR Tier 2, Section 9.5.2 regarding commitment to design communications subsystems in accordance with applicable codes and standards listed in FSAR Tier 2, Section 9.5.2.1.4, the staff finds the applicant complies with the requirements of 10 CFR 50.55(a). The staff's evaluation is documented in Section 9.5.2.4.5 of this report.

Based on the information provided in the FSAR Tier 2, Section 9.5.2, Interim Revision 3 markups, provided in the October 6, 2010, response to RAI 379, Question 9.5.2-12, the staff finds that the COMS equipment complies with the requirements of 10 CFR Part 50, Appendix A, GDC 1. The staff's evaluation is documented in Section 9.5.2.4.6 of this report.

Based on the information provided in the FSAR Tier 2, Section 9.5.2 regarding the physical independence of the COMS equipment, the staff finds the applicant has complied with the requirement of 10 CFR Part 50, Appendix A, GDC 2, GDC 3, and GDC 4. The staff finds the COMS equipment does not serve a function to support prompt hot shutdown of the reactor or maintain cold shutdown of the reactor, therefore, the staff concludes that the COMS equipment does not need to meet the requirements of 10 CFR Part 50, Appendix A, GDC 19. The staff's evaluation is documented in Section 9.5.2.4.6 of this report.

Based on the ITAAC provided in FSAR Tier 2, Section 2.5.12 and the Initial Tests in FSAR Tier 2, Section 14.2.12.11.7, the staff concludes the applicant complies with the requirements of 10 CFR 52.47(b)(1). The staff's review is documented in Section 9.2.4.6 of this report.

The review to address the security communication systems requirements to comply with the requirements of 10 CFR 73.45(e)(2)(iii), 10 CFR 73.46(f), and 10 CFR 73.55(j) is documented in Section 13.6 of this report.

9.5.3 Lighting System

9.5.3.1 *Introduction*

The plant lighting system provides adequate lighting during all plant operating conditions (e.g., normal operation and anticipated fire, transient, and accident conditions). This section includes design criteria, provisions for lighting in areas required for firefighting, provisions for lighting needed in areas for control and maintenance of safety-related equipment, and access routes to and from these areas.

9.5.3.2 *Summary of Application*

FSAR Tier 1: The FSAR Tier 1 information associated with this section is found in FSAR Tier 1, Revision 0, Section 2.5.9, "Lighting System." The lighting (LGT) system for the U.S. EPR includes the emergency lighting and special emergency lighting subsystems. The LGT system functions include illuminating the main control room and remote shutdown station workstations during normal and off-normal conditions. Lighting fixtures in the MCR are designed to withstand seismic design-basis loads without affecting plant safety functions. Emergency lighting in the MCR and RSS is powered from the emergency power supply system (EPSS). Emergency lighting and special emergency lighting sub-systems combined must provide at least 500 lux (lx) (50 foot-candles (fc)) illumination at the MCR and RSS workstations. Special emergency lighting in the MCR and RSS is powered from the Class 1E uninterruptible power supply system and must provide at least 100 lx (10 fc) illumination.

FSAR Tier 2: The applicant has provided an FSAR Tier 2 description of the lighting system designs in FSAR Tier 2, Revision 0, Section 9.5.3, "Lighting System," summarized here, in part, as follows:

The plant lighting system includes normal lighting, emergency lighting, special emergency lighting, escape route lighting, and security lighting system. Section 13.6 of this report discusses the security lighting system. Illumination levels provided by the lighting systems provide necessary lighting for normal plant operation, maintenance activities, and plant egress for safe evacuation of personnel from plant rooms and buildings when required. Lighting fixtures are staggered so that loss of a distribution panel does not result in a complete loss of lighting in a specified area. The emergency lighting system and special emergency lighting system fixtures are normally energized and combined to provide MCR and RSS lighting during normal and emergency operation. The special emergency lighting system fixtures are powered from the Class 1E EUPS, which maintains power to the fixtures for a minimum of 2 hours in the event of a station blackout. The 2 hours allow, if necessary, operators the ability to align the station blackout diesel generator to the Class 1E EPSS, restoring power to SBO loads, which includes emergency and special emergency lighting. No aluminum lighting fixtures are located in containment. Mercury vapor lamps or switches are not used in fuel handling areas or containment. Lighting system bulbs are not seismically qualified. Lighting fixtures located in the MCR and RSS are Seismic Category II. Emergency lighting and special emergency lighting circuits to lighting fixtures in the MCR and RSS are routed through Seismic Category I cable raceways or conduits. Normal, emergency, and special emergency lighting circuits are fed from their respective lighting panels and are physically separated from each other. The lighting circuits are non-Class 1E. Lighting circuits are electrically isolated from Class 1E circuits by the use of isolation devices and separation distance as indicated in IEEE 384-1992. The circuits will be separated by a barrier when separation distances cannot be met. Additionally, where normal, emergency, and special emergency lighting circuits share common areas, lighting circuits are color coded so that the lighting circuits are readily distinguishable. The MCR and RSS workstations are illumined to at least 500 lx (50 fc) during normal operation when lighting is provided by the emergency lighting and special emergency lighting systems. The special emergency lighting system provides at least 100 lx (10 fc) illumination in the MCR and RSS workstations for 2 hours when powered from the EUPS. Plant lighting fixtures are continuously energized and require no periodic testing. Escape route lighting and battery pack emergency lighting units are periodically inspected and tested to verify proper operation including battery capacity and integrity of the charging mechanism.

<u>Normal Lighting</u>

The normal lighting system provides lighting in plant buildings and site areas to support normal operation and plant maintenance activities. This system provides lighting for all indoor and outdoor areas. The non-Class 1E normal power supply system (NPSS) supplies power to the normal lighting system. The normal lighting fixtures are distributed with the emergency lighting fixtures in areas served.

<u>Emergency Lighting</u>

The emergency lighting system provides lighting in plant areas primarily containing safety-related equipment. The system is supplied with interruptible power from the EPSS backed up by emergency diesel generator and SBODG and from the NPSS backed up by SBODG. Emergency lighting fixtures powered from EPSS are normally illuminated and provide lighting for normal operation, control and maintenance of safety-related equipment for implementing plant safe-shutdown, and fire fighting. EPSS Division 2 and Division 3 power the emergency lighting system to provide approximately 67 percent of the MCR and RSS lighting. Emergency lighting fixtures powered by NPSS provide lighting in the Switchgear Building to support SBO operations. Battery pack emergency lighting fixtures are fixed, self-contained sealed-beam units with 8-hour battery packs. The batteries are charged from the NPSS during normal operation. The lighting fixtures provide lighting for operation of safety-related equipment for implementing plant safe-shutdown, firefighting, and access routes to the MCR and RSS.

<u>Special Emergency Lighting</u>

Special emergency lighting powered by EUPS Division 2 and Division 3 provides approximately 33 percent of the illumination in the MCR and RSS. The system provides lighting during normal operation and sufficient lighting during abnormal operation. The EUPS system provides an uninterruptible source of power for 2 hours to the special emergency lighting fixtures.

<u>Escape Route Lighting</u>

Escape route lighting provides illumination for safe evacuation of personnel from the plant rooms and buildings when normal light is lost. The fixtures are self-contained battery-backed sealed beam units maintained in a charged condition by the NPSS. The battery-backup automatically provides power during power interruption for at least 90 minutes following loss of normal power. The fixtures are installed in plant traffic areas such as stairwells, corridors, and building exit ways.

ITAAC: The ITAAC associated with FSAR Tier 2, Revision 0, Section 9.5.3.are specified in FSAR Tier 1, Section 2.5.9, “Lighting System.” FSAR Tier 1, Table 2.5.9-1, “Lighting System Inspections, Tests, Analyses, and Acceptance Criteria,” Item 2.1 states that inspections will be performed to verify that the lighting fixtures in the MCR are installed as designed and that a report exists which substantiates (based on type testing, analysis, or a combination thereof) that MCR lighting fixtures can withstand seismic design-basis loads without affecting plant safety functions. FSAR Tier 1, Table 2.5.9-1, Item 3.1 requires that test be performed to verify that emergency lighting in the MCR and RSS is powered from the EPSS. FSAR Tier 1, Table 2.5.9-1, Item 3.3 requires that test is performed to verify that emergency lighting and special emergency lighting sub-systems provide at least 500 lx (50 fc) of illumination to each workstation. FSAR Tier 1, Table 2.5.9-1, Items 3.2 and 3.4 require that tests be performed to verify that special emergency lighting in the MCR and RSS are powered from the EUPS and provide at least 100 lx (10 fc) of illumination to each workstation.

Technical Specifications: There are no Technical Specifications for this area of review.

9.5.3.3 *Regulatory Basis*

The relevant requirements of NRC regulations for this area of review, and the associated acceptance criteria, are specified in NUREG-0800, Section 9.5.3, “Lighting Systems,” and are summarized below. Review interfaces with other SRP sections also can be found in NUREG-0800, Section 9.5.3.

No GDC or RGs directly apply to the performance requirements for the lighting system. However, the plant lighting system must have the capability to (a) provide adequate lighting during all plant operating conditions; (b) provide adequate emergency lighting during all plant operating conditions including fire, transient, and accident conditions; and (c) address the effect of the loss of all alternating current power (i.e., during a station blackout) on the emergency lighting system.

Acceptance criteria adequate to meet the above requirements include:

- NUREG-0700, Revision 2, "Human-System Interface Design Review Guidelines," as it relates to accept table lighting levels. NUREG-0700 is based on the Illuminating Engineering Society of North America (IESNA) Lighting Handbook.

9.5.3.4 *Technical Evaluation*

The staff reviewed the following FSAR sections:

1. FSAR Tier 1, Chapter 2, Section 2.5.9

2. FSAR Tier 2, Chapter 9, Section 9.5.3

The staff determined that the applicant did not address the features related to effectiveness of control room lighting systems to support reliable human performance including evaluation with respect to the criteria specified in NUREG-0700. Therefore, in RAI 19, Question 09.05.03-1, the staff requested that the applicant address the staff's issue. In an August 8, 2008, response to RAI 19, Question 09.05.03-1, the applicant stated that MCR lighting will be designed in accordance with the guidance provided in NUREG-0700 to support reliable human performance. Specifically, the following features are provided: (1) shadows are avoided; (2) glare is minimized so it does not interfere with readability of displays, labels, or indicators; (3) reflectance levels are in accordance with NUREG-0700; and (4) task area luminance ratios provided in NUREG-0700 are not exceeded. On the basis of its review, the staff finds that the applicant has adequately addressed the issue. Therefore, the staff considers RAI 19, Question 09.05.03-1 resolved.

In RAI 19, Question 09.05.03-2, the staff requested that the applicant discuss special features to be included in areas containing rotating equipment to eliminate the risk of stroboscopic effect caused by flicker. In an August 8, 2008, response to RAI 19, Question 09.05.03-2, the applicant stated that stroboscopic effects caused from light flicker will be considered in the detailed layout of the lighting fixtures in relation to rotating equipment. The design considerations will include (1) use of lamps with low flicker indexes, (2) use of electronic ballasts having high-frequency or rectangular wave characteristics, and (3) staggering lighting on alternate phases of the three-phase power supply to provide light pattern overlap. On the basis of its review, the staff finds that the applicant has adequately addressed the issue. Therefore, the staff considers RAI 19, Question 09.05.03-1 resolved.

In RAI 19, Question 09.05.03-3, the staff requested that the applicant provide typical luminance ranges for normal lighting in all areas/rooms of the plant that are required for control and maintenance of equipment and plant access routes during normal plant operations. In an August 8, 2008, response to RAI 19, Question 09.05.03-3, the applicant provided typical illumination levels for normal lighting in plant areas and rooms required for control and maintenance of equipment and plant access routes during normal operations. On the basis of its review, the staff finds that the normal illumination levels conform to NUREG-0700. Therefore, the staff considers RAI 19, Question 09.05.03-3 resolved.

FSAR Tier 2, Section 9.5.3.2.2, "Emergency Lighting," states that the emergency lighting system provides lighting in plant areas primarily containing safety-related equipment. In RAI 19, Question 09.05.03-4, the staff requested the applicant to identify the areas, other than the MCR and RSS, where the emergency lighting will be utilized. In a September 8, 2008, response to RAI 19, Question 09.05.03-4, the applicant stated that rooms containing safety-related equipment to which routine access is expected for normal operations, surveillance, and maintenance activities (e.g., emergency core cooling systems pump rooms, switchgear rooms, instrumentation and control rooms, and Emergency Power Generating Buildings) will have approximately one-third of the area lighting supplied by the emergency lighting system. Additionally, emergency lighting will be provided for access to the Safeguard Buildings, Reactor Building, Fuel Building, and Emergency Power Generating Buildings. Emergency lighting is provided in other areas of Nuclear Island that have limited or no safety-related equipment. On the basis of its review, the staff determined that the applicant did not identify all areas/rooms where emergency lighting is provided (e.g., Class 1E DC equipment rooms, uninterruptible power supply rooms, operational support centers, and technical support centers, etc.) In follow-up RAI 114, Question 09.05.03-19, the staff requested the applicant to identify areas/rooms where emergency lighting will be provided. In a December 15, 2008, response to RAI 114, Question 09.05.03-19, the applicant provided a list of typical plant areas where emergency lighting is provided. On the basis of its review, the staff finds that the applicant adequately addressed the issue. Therefore, the staff considers RAI 114, Question 09.05.03-19 resolved.

Revision 0 of FSAR Tier 2, Section 9.5.3.3, “Safety Evaluation,” stated that lighting fixtures located in the MCR and RSS are Seismic Category Criteria II. The staff determined that the lighting fixtures located in the vicinity of safety-related equipment in other areas may not be supported so that they may adversely impact the safety-related equipment when subjected to seismic loading of a safe-shutdown earthquake. Therefore, in RAI 19, Question 09.05.03-5, the staff requested that the applicant address this issue. In an August 8, 2008, response to RAI 19, Question 09.05.03-5, the applicant stated that FSAR Tier 2, Section 9.5.3.3 will be changed to indicate, “Lighting fixtures located in the MCR and RSS and also those located within close proximity of safety-related systems or components outside of the MCR and RSS, are classified Seismic Category II.” The applicant further stated that U.S. EPR SSCs classified as Seismic Category II are designed to withstand SSE seismic loads without incurring a structural failure that permits deleterious interaction with any Seismic Category I SSCs or results in an injury to MCR occupants. On the basis of its review, the staff finds that the applicant has adequately addressed the issue. The staff confirmed that Revision 1 of the U.S. EPR FSAR, dated May 29, 2009, contains the changes committed to in the RAI response. Therefore, the staff considers RAI 19, Question 09.05.03-5 resolved.

In RAI 19 Question 09.05.03-6, the staff requested that the applicant discuss the mounting (Seismic Category Criteria) requirements of battery pack emergency lighting fixtures. In an August 8, 2008, response to RAI 19, Question 09.05.03-6, the applicant stated that battery pack emergency lighting fixtures will be classified as described in FSAR Tier 2, Section 3.2.1, “Seismic Classification.” For example, egress lighting fixtures located within close proximity to safety-related systems or components if they failed under seismic loading will be classified as Seismic Category II. On the basis of its review, the staff finds that the applicant has adequately addressed the issue. Therefore, the staff considers RAI 19, Question 09.05.03-6 resolved.

FSAR Tier 2, Section 9.5.3.3 states that lighting fixtures in the MCR and RSS are Seismic Category Criteria II. In RAI 19, Question 09.05.03-7, the staff requested that the applicant provide its basis for categorizing these lighting fixtures as Seismic Category Criteria II instead of Seismic Category Criteria I. In an August 8, 2008, response to RAI 19, Question 09.05.03-7, the applicant stated that the plant lighting system is non-safety-related. The Seismic Category II classification for the lighting fixtures located in the MCR and RSS meets the guidance provided in RG 1.29. Seismic Category II components are designed to withstand SSE seismic loads without incurring a structural failure that permits deleterious interaction with any Seismic Category I SSCs or that could result in injury to MCR occupants. On the basis of its review, the staff finds that the applicant has adequately addressed the issue. Therefore, the staff considers RAI 19, Question 09.05.03-7 resolved.

Adequate lighting is needed in areas requiring manual actions during an SBO event where emergency lighting is not installed. Therefore, in RAI 19, Question 09.05.03-8, the staff requested that the applicant provide a description of the available lighting to be provided for this situation. In an August 8, 2008, response to RAI 19, Question 09.05.03-8, the applicant stated that there are no identified areas in the U.S. EPR where manual actions are required during an SBO event where emergency lighting is not installed. The applicant further stated that while the use of portable lighting is not anticipated for SBO event mitigation activities, portable lights are provided for the fire brigade as indicated in RG 1.189 and are available for use if necessary. On the basis of its review, the staff finds that the applicant has adequately addressed the issue. Therefore, the staff considers RAI 19, Question 09.05.03-8 resolved.

The staff determined that FSAR Tier 2, Section 9.5.3.5, "References" is incomplete. Therefore, in RAI 19, Question 09.05.03-9, the staff requested that the applicant include IESNA and IEEE Std 384 in FSAR Tier 2, Section 9.5.3.5. In an August 8, 2008, response to RAI 19, Question 09.05.03-9, the applicant stated that Section 9.5.3.5 will be revised to add the references. On the basis of its review, the staff finds that the applicant has adequately addressed this issue. The staff confirmed that Revision 1 of the U.S. EPR FSAR, dated May 29, 2009, contains the changes committed to in the RAI response. Accordingly, the staff finds that the applicant has adequately addressed this issue and, therefore, the staff considers RAI 19, Question 09.05.03-9 resolved.

FSAR Tier 2, Section 9.5.3.1, "Design Basis," states that isolation is provided for lighting systems powered from Class 1E sources by a Class 1E isolation device located at the motor control center feed to the distribution panel. It was not clear to the staff whether a series of circuit breakers/fuses or a single circuit breaker/fuse would be used. Therefore, in RAI 19, Question 09.05.03-10, the staff requested that the applicant provide clarification. The staff also requested that the applicant address conformance with RG 1.75, "Criteria for Independence of Electrical Safety Systems." Additionally, the staff suggested that FSAR Tier 1, Section 2.5.9 be revised to include an ITAAC for this item. In a September 8, 2008, response to RAI 19, Question 09.05.03-10, the applicant stated that a single Class 1E circuit breaker or fuse located at the motor control center is used as the isolation device. The applicant stated that this isolation device meets the guidance provided in RG 1.75. However, the staff noted that RG 1.75, Position C(1) recommends analysis and periodic testing of the isolation device. FSAR Tier 1, Tables 2.5.1-3, "Class 1E Emergency Power Supply System ITAAC," and 2.5.2-3, "Class 1E Uninterruptible Power Supply ITAAC," include ITAAC of the isolation devices (Table 2.5.1-3, Item 5.2 and Table 2.5.2-3, Item 5.2). However, the ITAAC (Table 2.5.1-3, Item 5.2 and Table 2.5.2-3, Item 5.2) only states that an inspection will be performed. The staff did not understand how RG 1.75, Position C(1) would be verified by an inspection. Therefore, in follow-up RAI 114, Question 09.05.03-18, the staff requested that the applicant modify Table 2.5.1-3, Item 5.2 and Table 2.5.2-3, Item 5.2 to include testing ("… periodic testing of circuit breakers … during every refueling must demonstrate that the overall coordination scheme under multiple faults of non-safety-related loads remains within the limits specified in the design criteria for the nuclear power plant,") and analysis (the breaker time-current trip characteristics, for circuit faults "under bolted or arcing fault conditions (assuming multiple faults of all non-safety-related loads and load current of all safety-related circuits) will cause the nearest circuit breaker … to interrupt the fault current prior to initiation of a trip of any upstream protective device,") to verify that recommendations of RG 1.75 are met. In a December 15, 2008, response to RAI 114, Question 09.05.03-18, the applicant stated the FSAR Tier 1, Table 2.5.1-3, Item 5.2 and FSAR Tier 1, Table 2.5.2-3, Item 5.2 have been revised as indicated in the November 26, 2008, response to RAI 116, Question 14.03.06-5. The revised text indicates type tests, analyses, or a combination of type tests and analyses of the isolation devices are performed to verify the isolation device between the EPSS Class 1E components and non-Class 1E circuits prevent credible faults from propagating into the EPSS. The applicant stated that the commitment to perform the periodic testing of circuit breakers during every refueling to demonstrate that the overall coordination scheme under multiple faults of non-safety-related loads remain within the limits specified in the design criteria is appropriately located in FSAR Tier 2, Chapter 8. On the basis of its review, the staff finds that the applicant adequately addressed the issue. Therefore, the staff considers RAI 114, Question 09.05.03-18 resolved.

FSAR Tier 2, Section 9.5.3.2.2 states that EPSS Division 2 and Division 3 power the emergency lighting system to provide approximately 67 percent of the MCR and RSS lighting. FSAR Tier 2, Section 9.5.3.2.3, "Special Emergency Lighting," states that EUPS Division 2 and Division 3 power special emergency lighting to provide approximately 33 percent of the illumination in the MCR and RSS. FSAR Tier 2, Section 9.5.3.3 states that MCR and RSS workstations are illuminated to at least 500 lx (50 fc) during normal operation when lighting is provided by the emergency lighting and special emergency lighting systems. The special emergency lighting system provides at least 100 lx (10 fc) illumination in the MCR and RSS workstations for 2 hours when powered from the EUPS. In RAI 19, Question 09.05.03-11, the staff requested that the applicant address the following:

1. Is normal lighting (supplied by non-Class 1E power system) provided in the MCR and RSS?
2. What is the total illumination level in MCR and RSS?
3. Confirm that MCR and RSS workstations (seated operator station, reading, writing, and data recording) are illuminated to 1000 lx (100 fc) (NUREG-0700).
4. Explain the relationship of percentages and actual footcandles. (Explain how 67 percent and 33 percent corresponds to 500 lx (50 fc) and 100 lx (10 fc), respectively.)?

In an August 8, 2008, response to RAI 19, Question 09.05.03-11, the applicant stated that there is not a non-Class 1E power supply that provides "normal" MRC or RSS lighting for ambient lighting during normal operating conditions. MCR and RSS lighting is provided by emergency lighting system and special emergency lighting system. The operator's stations in the MCR and RSS have nominal illumination levels of 1000 lx (100 fc). The MCR and RSS workstations (seated operator station, reading, writing and data recording) are illuminated to 1000 lx (100 fc). The applicant stated that FSAR Tier 2, Section 9.5.3.3 will be changed to indicate that "The MCR and RSS workstations are illuminated to at least 1000 lx (100 fc) and the safety-related panels (e.g., safety information and control system panels as described in Section 7.1.1.3.1) are illuminated to at least 500 lx (50 fc) during normal operation when lighting is provided by the emergency lighting and special emergency lighting systems." Additionally, FSAR Tier 1, Section 2.5.9.3.3 and FSAR Tier 1, Table 2.5.9-1 will be revised as described in the response. The applicant further stated that the special emergency lighting provides a minimum illumination of 100 lx (10 fc) in accordance with NUREG-0700 recommendations for emergency lighting.

The special emergency lighting is expected to provide greater illumination than the minimum recommended. On the basis of its review, the staff finds that the applicant has adequately addressed this issue. The staff confirmed that Revision 1 of the U.S. EPR FSAR, dated May 29, 2009, contains the changes committed to in the RAI response. Accordingly, the staff finds that the applicant has adequately addressed this issue and, therefore, the staff considers RAI 19, Question 09.05.03-11 resolved.

FSAR Tier 2, Section 9.5.3 contains no design description of panel lighting in the MCR (Refer to NUREG-0700) at the safety-related panels. Therefore, in RAI 19, Question 09.05.03-12, the staff requested that the applicant provide a design description of panel lighting in the MCR or provide a technical basis for not doing so. In an August 8, 2008, response to RAI 19, Question 09.05.03-12, the applicant states, "The U.S. EPR main control room (MCR) consists of operator workstations (operator computer terminals), a limited number of safety information and control system (SICS) panels and plant overview panels from the process information and control system. The operator workstations are PICS screen based workstations, eliminating the need for the operator to move locations and operate equipment from a different location in the MCR. The SICS panels are the safety-related panels in the MCR. Plant overview panels are non-safety-related monitors that do not require lighting. The emergency lighting and special emergency lighting systems provide the lighting in the MCR. This lighting is normally illuminated from these systems and is provided for normal and emergency operations in all areas in the MCR including the SICS panels. The SICS panels are provided with at least 500 lx (50 fc) illumination from the emergency lighting and special emergency lighting systems." On the basis of its review, the staff finds that the applicant adequately addressed the staff issue. The staff agrees that no panel lighting in the MCR is required. Therefore, the staff considers RAI 19, Question 09.05.03-12 resolved.

In RAI 19, Question 09.05.03-13, the staff requested that the applicant include the following in FSAR Tier 1, Section 2.5.9 and revise Table 2.5.9-1 or provide a justification for not including them: (1) The control room emergency and special emergency lighting system is electrically independent and physically separated and (2) dc self-contained sealed-beam units provide illumination levels equal to or greater than those recommended by the IESNA in those areas of the plant required for power restoration and/or recovery from fire, for at least 8 hours. In an August 8, 2008, response to RAI 19, Question 09.05.03-13, the applicant stated that "approximately 50 percent of the overall lighting in the main control room (MCR) from the emergency lighting and special emergency lighting systems is supplied from Division 2 emergency power supply system (EPSS) and Class 1E uninterruptible power supply system (EUPS), respectively. The other 50 percent of the overall lighting in the MCR from the emergency lighting and special emergency lighting is supplied from Division 3 EPSS and EUPS, respectively. Electrical independence and physical separation is provided between the Division 2 and Division 3 components and circuits. Electrical independence and physical separation is not needed between emergency lighting and special emergency lighting systems, since these lighting systems are both powered from Class 1E power sources, and they are powered from systems in the same division. Adequate lighting remains in service in the MCR if there is a loss of power from one division." Additionally, the applicant stated that FSAR Tier 1, Section 2.5.9 and FSAR Tier 1, Table 2.5.9-1 will be revised to include ITAAC Item 3.5. On the basis of its review, the staff agrees that electrical independence and physical separation is not needed between emergency lighting and special emergency lighting systems. ITAAC regarding electrical independence and physical separation between the Division 2 and Division 3 components and circuits is provided in FSAR Tier 1, Section 2.5. The staff concludes that the applicant has adequately addressed this issue. The staff confirmed that Revision 1 of the

U.S. EPR FSAR, dated May 29, 2009, contains the changes committed to in the RAI response. Therefore, the staff considers RAI 19, Question 09.05.03-13 resolved.

FSAR Tier 1, Section 2.5.9, Subsection 2.1 states that lighting fixtures in the MCR are Seismic Category II and can withstand seismic design basis loads without affecting plant safety function. FSAR Tier 2, Section 9.5.3.3 states that lighting fixtures in the MCR and RSS are Seismic Category II. In RAI 19 Question 09.05.03-14, the staff requested that the applicant modify FSAR Tier 1, Section 2.5.9, Subsection 2.1 and Table 2.5.9-1 to address lighting fixtures in the MCR and RSS instead of lighting fixtures in the MCR only. In an August 8, 2008, response to RAI 19, Question 09.05.03-14, the applicant stated that FSAR Tier 1, Section 2.5.9 and FSAR Tier 1, Table 2.5.9-1 will be revised to address lighting fixtures in the MCR and RSS. On the basis of its review, the staff finds that the applicant has adequately addressed this issue. The staff confirmed that Revision 1 of the U.S. EPR FSAR, dated May 29, 2009, contains the changes committed to in the RAI response. Therefore, the staff considers RAI 19, Question 09.05.03-14 resolved.

In FSAR Tier 1, Table 2.5.9-1, Item 3.2, under Acceptance Criteria, RSS appears twice. In RAI 19, Question 09.05.03-15, the staff requested that the applicant change the first RSS to MCR. In an August 8, 2008, response to RAI 19, Question 09.05.03-15, the applicant stated that FSAR Tier 1, Table 2.5.9-1 will be revised as described in the response. On the basis of its review, the staff finds that the applicant has adequately addressed this issue. The staff confirmed that Revision 1 of the U.S. EPR FSAR, dated May 29, 2009, contains the changes committed to in the RAI response. Therefore, the staff considers RAI 19, Question 09.05.03-15 resolved.

FSAR Tier 2, Section 9.5.3.2.2, does not clearly state where 8-hour battery pack emergency lighting units will be used. RG 1.189 recommends 8-hour battery pack emergency lighting should be provided in areas needed for operation of safe-shutdown equipment and access and egress routes thereto. Therefore in RAI 19, Question 09.05.03-16, the staff requested that the applicant explain how it met the above recommendation or to provide justification for not meeting the RG 1.189 recommendation. In an August 8, 2008, response to RAI 19, Question 09.05.03-16, the applicant stated that FSAR Tier 2, Section 9.5.3.2.2 will be revised to indicate reference to Section 9.5.1 for use and location of emergency lighting for fire fighting and operator actions. In follow-up RAI 114, Question 09.05.03-20, the staff requested that the applicant modify Section 9.5.3.2.2 as follows: “Battery pack emergency lighting fixtures are fixed, self-contained sealed beam units with 8-hour battery packs. The batteries are charged from the NPSS during normal operation. The egress route from the MCR to the RSS is illuminated by independent fixed, self-contained 8-hour rated battery powered lighting units. Other post-fire safe-shutdown activities performed by operators outside the MCR and RSS are supported by independent fixed, self-contained 8-hour rated battery powered lighting units at the task location and in access and egress routes. Refer to FSAR Tier 2, Section 9.5.1 for additional information regarding fire fighting and operator actions.” In a December 15, 2008, response to RAI 114, Question 09.05.03-20, the applicant stated the FSAR Tier 2, Section 9.5.3.2.2 will be revised to add, “Battery back emergency lighting fixtures are fixed, self-contained sealed beam units with eight-hour battery packs. The batteries are charged from NPSS during normal operation.” The applicant further stated that the information related to the egress route from the MCR and RSS being illuminated by the battery pack emergency lighting fixtures, and the use of the 8-hour battery powered lighting units for post-fire safe shutdown activities, is already contained in the referenced FSAR Tier 2, Section 9.5.1. On the basis of its review, the staff finds that the applicant adequately addressed the issue. The staff confirmed that Revision 1 of the U.S. EPR FSAR, dated May 29, 2009, contains the changes committed to in the RAI response. Therefore, the staff considers RAI 114, Question 09.05.03-20 resolved.

FSAR Tier 2, Section 9.5.3.4, "Inspection and Testing Requirements," states that the escape route lighting and battery pack emergency lighting units are inspected and tested periodically. In RAI 19, Question 09.05.03-17, the staff requested that the applicant identify the program which will address inspection and testing requirements. In an August 8, 2008, response to RAI 19, Question 09.05.03-17, the applicant stated that periodic testing of escape route lighting will meet the guidance of NFPA 101-2006 for periodic testing of emergency lighting equipment. The 8-hour battery pack emergency lighting fixtures will be periodically tested to meet the guidance of RG 1.189. A testing program that meets the recommendations as developed by the Electric Power Research Institute for emergency battery lighting unit maintenance will verify the operation of the 8-hour batteries and lighting units to perform their function. The applicant further stated that FSAR Tier 2, Section 9.5.3.4 will be changed to add, "Periodic testing of escape route lighting is in accordance with the guidance of NFPA 101-2006 (Reference 4) for periodic testing of emergency lighting equipment. 8-hour battery pack emergency lighting fixtures are periodically tested to meet the guidance of RG 1.189." Additionally, FSAR Tier 2, Section 9.5.3.5 will be changed to add, "4. NFPA 101-2006, 'Life Safety Code – 2006 Edition,' National Fire Protection Association, 2005." On the basis of its review, the staff finds that the applicant has adequately addressed this issue. The staff confirmed that Revision 1 of the U.S. EPR FSAR, dated May 29, 2009, contains the changes committed to in the RAI response. Therefore, the staff considers RAI 19, Question 09.05.03-17 resolved.

The staff finds that normal, emergency, special emergency, and escape route lighting systems will provide adequate lighting during normal and emergency plant operating conditions. The emergency, special emergency, and escape route lighting system will provide adequate station lighting in all vital areas from onsite power sources during the full spectrum of accident and/or transient conditions and to the access routes to and from these areas. The staff finds the information provided for the plant lighting system sufficient to meet the guidance of SRP Section 9.5.3.

9.5.3.5 *Combined License Information Items*

There are no COL information items specified in FSAR Tier 2, Table 1.8-2 for this area of review. No additional COL information items need to be included in FSAR Tier 2, Table 1.8-2 for lighting systems consideration.

9.5.3.6 *Conclusions*

Based on its review, the staff concludes that the design of the lighting system for the U.S. EPR conforms to the applicable staff positions and industry standards. The staff also concludes that the lighting system is in accordance with the lighting levels recommended in NUREG-0700, which is based on the IESNA Lighting Handbook. Therefore, the staff finds the U.S. EPR design acceptable.

9.5.4 Diesel Generator Fuel Oil Storage and Transfer System

9.5.4.1 *Introduction*

The review of the U.S. EPR Class 1E emergency diesel generator fuel oil storage and transfer system (DGFOSTS) is to assure compliance of the system design with the requirements of

GDC 2, GDC 4, GDC 5, and GDC 17 and 10 CFR 52.47(b)(1). In addition, the review covers the quality and the quantity of fuel oil stored onsite and the availability and procurement of additional fuel from offsite sources.

Each EDG has a separate and independent DGFOSTS. Each system is comprised of a storage tank, a day tank, two sets of pumps (fuel oil transfer and injection), and related piping and controls. The system stores a minimum of 7 days of fuel oil and delivers it to the EDG as required for continuous operation.

9.5.4.2 *Summary of Application*

FSAR Tier 1: The FSAR Tier 1, Section 2.5.4, "Emergency Diesel Generator," describes the principal performance characteristics and safety functions of the emergency diesel generators and their supporting equipment, and includes Table 2.5.4-1, "Emergency Diesel Generator Equipment Mechanical Design," Table 2.5.4-2, "Emergency Diesel Generator Support Systems Electrical Equipment Design," Table 2.5.4-3, "Emergency Diesel Generator Electrical Equipment Design," Table 2.5.4-4, "Emergency Diesel Generator ITAAC," and FSAR Tier 1, Figure 2.5.4-1, "Emergency Diesel Generator Fuel Oil Storage and Transfer System Functional Arrangement." FSAR Tier 1, Section 2.5.4, Items 3.9 and 3.10 states that each EDG has a fuel oil storage tank and fuel oil day tank, respectively. FSAR Tier 1, Section 2.5.4, Item 3.11 states that each fuel oil transfer pump capacity is greater than the EDG fuel oil consumption at the continuous rating. Other items in this section state the design requirements for the ASME Section III and Seismic Category I portions of all of the EDG support systems.

FSAR Tier 2: The applicant has provided a system description in FSAR Tier 2, Section 9.5.4, "Diesel Generator Fuel Oil Storage and Transfer System," summarized here, in part, as follows:

Each EDG has its own dedicated and independent DGFOSTS as described in FSAR Tier 2, Section 9.5.4. Each system is comprised of a storage tank, a day tank, two sets of pumps (fuel transfer and delivery and injection) and related piping, filters, and controls. The system stores a minimum of 7 days of fuel oil and delivers it to the EDG as required for continuous operation.

ITAAC: FSAR Tier 1, Table 2.5.4-4, provides ITAAC requirements for the EDGs. Item 2.1 of this table requires verification of the functional arrangement of the DGFOSTS. Table 2.5.4-4 provides specific requirements for the fuel oil storage tank (Item 3.9), fuel oil day tank (Item 3.10), and fuel oil transfer pumps (Item 3.11). In addition, there are other ITAAC that apply generally to all of the EDG support systems, including Items 2.2, 3.7, 3.13, 3.16 through 3.24, 4.1, 4.2, 4.3, 5.2, 5.4, and 6.5.

Technical Specifications: FSAR Tier 2, Chapter 16, TS 3.8.1, "AC Sources – Operating," provides EDG requirements. Surveillance Requirements 3.8.1.4 through 3.8.1.6, 3.8.3.1, 3.8.3.3 and 3.8.3.5 provide day tank, storage tank and transfer pump requirements. Limiting Conditions for Operation for the DGFOSTS are given in Chapter 16, LCO 3.8.3, "Diesel Fuel Oil, Lube Oil, and Starting Air." In addition, TS 5.5.12, "Diesel Fuel Oil Testing Program," provides requirements for a program to ensure the quality of the diesel fuel oil.

9.5.4.3 *Regulatory Basis*

The relevant requirements of NRC regulations for this area of review, and the associated acceptance criteria, are specified in NUREG-0800, Section 9.5.4, "Emergency Diesel Engine Fuel Oil Storage and Transfer System," and are summarized below. Other areas of review (other SRP sections) that include interfaces with this SRP section are identified in NUREG-0800, Section 9.5.4.

1. GDC 2, as it relates to SSCs important to safety that must be protected from, or capable of withstanding, the effects of such natural phenomena as earthquakes, tornadoes, hurricanes, and floods as described in FSAR Chapters 2 and 3.

2. GDC 4, as it relates to SSCs important to safety that must be protected from, or capable of withstanding, the effects of externally generated missiles, internally generated missiles, pipe whip and jet impingement forces associated with pipe breaks.

3. GDC 5, as it relates to the capability of shared DGFOSTS systems and components important to safety to perform required safety functions.

4. GDC 17, as it relates to the capability of the DGFOSTS to support the requirement for independence, redundancy and testability of the onsite electric power system to assure post-accident safe shutdown.

5. 10 CFR 52.47, Paragraph (b)(1), which requires that the U.S. EPR application contain the proposed ITAAC that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a plant that incorporates the design certification is built and will operate in accordance with the U.S. EPR, the provisions of the Atomic Energy Act of 1954, and NRC regulations.

Acceptance criteria adequate to meet the above requirements include:

1. RG 1.26 provides guidance for the appropriate quality group classification of system components. Although this RG does not specifically apply to fuel systems, the guidance can be applied to the DGFOSTS components.

2. RG 1.29 provides guidance for the appropriate seismic classification of system SSCs.

3. The DGFOSTS design, fuel quality, and tests are specified in RG 1.137, "Fuel Oil Systems for Standby Diesel Generators," Revision 1, Regulatory Positions C.1 and C.2. RG 1.137, Regulatory Position C.1 addresses materials, physical arrangement, and applicable codes and regulations. Regulatory Position C.2 addresses fuel oil quality and testing. RG 1.137 was issued in October 1979 and, consequently, the referenced standards have been replaced and/or updated. The applicant has committed to a design in accordance with the updated or replacement versions of the standards referenced in the RG. The quality of fuel oil is determined by performing suitable tests and is replaced when it does not meet standards. Prior to adding new fuel, tests for specific gravity, water sediment, and viscosity should be tested and fuel not meeting standards should not be added to the tank.

4. NUREG/CR-0660 provides guidance based on operating experience with EDGs.

5. ANSI/ANS-59.51, "Fuel Oil Systems for Safety-Related Emergency Diesel Generators," regarding the onsite fuel oil storage and transfer for each of the four redundant emergency power supplies being sufficient to support operation of the emergency power supply following any design basis event and a continuous loss of offsite power either for 7 days, or for the time required to replenish the fuel from sources outside the plant site

following any design event without interruption of the operation of the emergency power supply, whichever is longer.

9.5.4.4 *Technical Evaluation*

The staff reviewed the design description of the DGSFOSTS in the FSAR, in accordance with NUREG-0800, Section 9.5.4.

Mechanical System Aspects

FSAR Tier 2, Section 9.5.4 describes the DGFOSTS. Each DGFOSTS is comprised of a storage tank, a day tank, four pumps (two transfer pumps and two fuel-injection pumps) and related piping, valves, duplex strainers, duplex filters, flame arrestors, instrumentation, and controls. Each EDG is supplied with a dedicated and independent DGFOSTS.

In accordance with RG 1.26 and RG 1.29, each DGFOSTS is classified as safety-related, Quality Group C, ASME Section III Class 3, and Seismic Category I as shown in FSAR Tier 1, Table 2.5.4-1 and Table 2.5.4-2, and FSAR Tier 2, Table 3.2.2-1.

The portions of the DGFOSTS that are part of the engine assembly are Seismic Category I but are not within the ASME Section III boundary; therefore, the quality group classifications for these SSCs are Quality Group E. The non-fluid-containing components of the system do not have a quality group classification, since RG 1.26 only pertains to water and steam containing components.

Each DGFOSTS contains two (redundant) 100 percent transfer pumps to transfer fuel oil from the storage tanks to the day tanks. Transfer pumps are provided with over-pressure protection by relief valves that return fuel to the storage tank. The suction lines from the storage tank to the transfer pumps contain duplex strainers. Duplex filters are in the discharge piping of the transfer pumps. The discharge piping is connected to the top of the day tank. In addition, the engine-driven fuel pump suction piping from the day tank has duplex strainers, and the pump discharge piping has duplex filters. The duplex filters and strainers can be cleaned without interrupting fuel oil flow.

An electric-driven positive-displacement auxiliary fuel pump is provided to supply fuel in the event of failure of the engine-driven fuel pump. The auxiliary fuel pump is capable of delivering full fuel flow and pressure for operation at 110 percent engine continuous rating. In the event of low fuel oil pressure during operation, the auxiliary fuel pump starts automatically to supply the required fuel flow.

The elevated position of the day tank, with respect to the diesel engine, enables fuel oil to be supplied to the engine-driven fuel oil pump by gravity flow. Excess fuel from the engine is returned to the day tank. In the event of a loss of adequate fuel oil pressure from the diesel engine-driven fuel oil pump, the fuel oil auxiliary pump will start automatically, taking suction from the supply line from the day tank and thus supply the necessary fuel oil pressure to the diesel engine fuel injectors. During startup, the auxiliary fuel pump operates until the engine-driven pump reaches capacity for continued operation. These design functions meet the guidelines of RG 1.137, Regulatory Position C.

Each DGFOSTS, with the exception of the fill and vent connections, is located in the Emergency Power Generation Building (EPGB) for each emergency power division. Each EPGB is a safety-related, Seismic Category I building, which is designed to withstand the effects of earthquakes, tornadoes, hurricanes, floods, external missiles, and other natural phenomena, as described in FSAR Tier 2, Sections 3.3, “Wind and Tornado Loadings,” through 3.8, “Design of Category I Structures.” The fill and vent lines terminate outside the EPGB. The maximum probable flood level does not exceed the elevation of the fill and vent connections; therefore, they are not susceptible to flooding. The applicant has stated in FSAR Tier 2, Section 9.5.4.2.2, that there are sufficient features and administrative controls on the storage tank outside fill, vent, and pump-out lines to protect against damage from vehicles, tornadoes missiles, floods, extreme cold, and accidental contamination, including the following:

- There are two fuel unloading stations for each tank (an alternate fill location provides the capability to fill the storage tanks in the event that the normal fill location is unavailable).
- There are two fuel oil storage tank vent paths leading to the outside of the EPGB.
- The two fill and vent locations are geographically separated and out of line-of-sight of each other.
- All vent and fill locations are located above the flood level.
- The indoor portion of each fill line is equipped with an isolation valve that is located inside the EPGB fuel tank room.
- The fill line isolation valves are normally closed except during the filling operation.

The applicant concluded that the DGFOSTS would not prevent the internal SSCs of the system from meeting their design basis functions. It is unlikely that a single event could disable multiple fill locations to the extent that they could not be restored to operability within 7 days before fuel delivery would be required. Therefore, the staff finds that the DGFOSTS meets the requirements of GDC 2.

Each EDG division is located in a dedicated room in the EPGB, which contains support systems for that division. The four divisions are separate and independent from one another. All pressure lines located in a division support only that division. A failure of any pressure line will only have the potential to impact the function of the SSCs in that division. There are no high- or moderate-energy lines in the EPGB whose failure could alter the function of more than one DGFOSTS. Therefore, the staff finds that the DGFOSTS meets the requirements of GDC 4.

Each unit has four independent EDGs, each with a separate and independent DGFOSTS that is not shared with other EDGs. The U.S. EPR is a single unit design. Therefore, the staff finds that the DGFOSTS meets the requirements of GDC 5.

SRP Section 9.5.4 acceptance criteria include the guidance of ANSI/ANS-59.51-1997. This standard specifies that each EDG shall have onsite fuel oil storage sufficient to operate the diesel generator following any design-basis accident and loss of offsite power for either 7 days, or the time required to replenish the oil from sources outside the plant site following any limiting design-basis accident without interrupting the operation of the diesel, whichever is longer.

Following a LOOP, the DGFOSTS provides onsite storage and delivery of fuel oil for at least 7 days of diesel generator operation at the continuous rating, in accordance with ANSI/ANS-59.51. There is an alarm that warns the operator that the fuel inventory is below the required 7-day quantity, and that the storage tank needs to be refilled.

The DGFOSTS design features, including redundancy and independence, and the provisions for testing the system capability support the requirement for an onsite electric power system to assure post-accident safe shutdown and, therefore, meet the requirements of GDC 17.

The applicant has stated in FSAR Tier 2, Section 9.5.4.1, that the active components of the DGFOSTS can be tested during plant operation and that provisions are made to allow inservice inspection of components at appropriate times specified in the ASME Boiler and Pressure Vessel (B&PV) Code, Section XI, "Rules for In-Service Inspection of Nuclear Power Plant Components." This meets the acceptance criteria of SRP Section 9.5.4.

Fuel in the system, including the storage and day tank, and associated piping is maintained above the cloud point of the stored fuel at all times. This is accomplished by locating all portions of the system in heated space within the EPGB, with the exception of the fill and pump-out station. The staff finds this meets the guidance of RG 1.137, Regulatory Position C.1.

RG 1.137, Regulatory Position C.2 specifies guidelines for corrosion control and the initial and continuing quality of fuel oil. The storage tank bottom is constructed so that a low point sump exists for collection and drainage of any water or sediment that may be present. Fill lines and transfer pump suction lines are located above the sump to preclude disturbance of sediment or water which might lead to the introduction of contaminants into the fuel oil system.

The staff notes that the design is in accordance with the recommendations of NUREG/CR-0660 regarding tank-bottom drains. The storage tank fill piping contains an inline filter to preclude sediment particles from being introduced into the storage tank during fuel delivery. A sampling connection is provided on the bottom of each tank for periodic sampling of the fuel oil for quality and for drawing off any accumulated condensation and sediment. The tank fill design provides reasonable assurance that sediment will not be stirred up during replenishment. This meets the guidelines specified in NUREG/CR-0660.

NUREG/CR-0660, also recommends EPGB floors to be painted with concrete or masonry type paint in all rooms to prevent concrete abrasive dust becoming airborne. The airborne dust had previously caused malfunctions of electrical contacts in existing nuclear power plants. Therefore in RAI 152, Question 09.05.04-12, the staff requested that the applicant describe the design protective measures that were implemented to prevent concrete dust from becoming airborne in the EPGB. The staff also suggested that the FSAR be changed to reflect this information. In a January 30, 2009, response to RAI 152, Question 09.05.04-12, the applicant stated:

> Section 11.4 of American Concrete Institute (ACI) 302.1, "Guide for Concrete Floor and Slab Construction," identifies the cause of dusting to be the deterioration of a surface laitance layer that was formed during the initial placement and curing of the fresh concrete at the time of construction. The concrete industry has improved the performance of concrete by incorporating new technologies and lessons learned into standards such as ACI 304R, "Guide for Measuring, Mixing, Transporting and Placing Concrete." Proper placement and curing of fresh concrete minimizes the potential for formation of concrete abrasive dust. FSAR Tier 2, Section 3.8.3.6, "Materials, Quality Control, and Special Construction Techniques," identifies the specific ACI codes, including ACI 304R, that are being invoked to place fresh concrete in a manner so as to achieve the desired results.

> Protective coatings may be applied to concrete surfaces as a remedial measure when adverse environmental and finishing conditions are encountered during construction. FSAR Tier 2, Section 6.1.2 provides organic protective coating details for this application, with specific detail for concrete surfaces outside containment described in Section 6.1.2.1.2.2.

The staff reviewed this information including statements in FSAR Tier 2, Section 3.8.3.6 and Section 6.1.2.1.2.2, "Outside Containment." The staff found that these FSAR sections adequately address the recommendations of NUREG/CR-0660 related to preventing airborne concrete. Therefore, the staff considers RAI 152, Question 09.05.04-12 resolved.

SRP Section 9.5.4, Paragraph 9.5.4 I.1.G, specifies that the design include the capability to detect and control system leakage, including isolating system portions in the event of excessive leakage or component malfunction. The DGFOSTS is located inside the EPGB with the exception of the outside fill, vent and pump-out locations. The outside fill locations only contain fuel during the filling operation. The external fill locations are designed to meet local, State, and Federal regulations for spill protections.

The portions of the DGFOSTS inside the EPGB are located above ground and leakage in the system will be identified during diesel surveillance runs or routine operator rounds. In the event of a large leak during unattended periods, the fuel tanks are equipped with low level alarms, and the fuel would drain to the local building sump. The local building sump is also equipped with a level alarm that will notify operations of an abnormal condition. Supply and branch lines have isolation valves that can be operated to minimize the impact of leaks. SSCs not required for EDG operation can be isolated to maintain EDG operability. The staff finds that the DGFOSTS design meets the SRP guidance for system leak detection and control.

As stated above, each EDG has a separate and independent DGFOSTS. Therefore, a single failure in any one DGFOSTS will affect only its EDG. This arrangement meets the guidelines specified in SRP Section 9.5.4.

The day tank is automatically filled from the storage tank on a day tank low level signal. According to FSAR Tier 2, Table 9.5.4-1, "DGFOSTS Indicators and Alarms," the storage tanks and day tanks have high level and low level alarms, and the fuel oil strainers and filters have high differential pressure alarms. Each of these is a local alarm at the EDG control panel, and there is a common trouble alarm in the main control room that includes all of these alarms. This design is in accordance with ANSI/ANS-59.51 and SRP Section 9.5.4.

Each DGFOSTS is designed to minimize the potential for exposure to ignition sources, such as open flames and hot surfaces. The day tank and storage tank are located together in a separate room away from the diesel engine. There is no elevated fuel oil piping adjacent to the engine. Piping from the day tank to the engine drops down below the elevation of the engine until it reaches the engine. The storage tanks and day tanks have flame arrestors on the vent lines. The engine exhaust system is insulated to prevent potential fuel oil spray from directly contacting high temperature components. This meets the guidelines of SRP Section 9.5.4.

Items 3.9 and 3.10 of FSAR Tier 1 Table 2.5.4-4 will confirm the specified volumes for the fuel oil day tank and the fuel oil storage tank. Item 3.11 will confirm the capacity of the fuel oil transfer pumps. In addition to these confirmations, other items of Table 2.5.4-4 will confirm the configuration, location, and safety classifications of the DGFOSTS.

The staff finds the FSAR Tier 1 information sufficient to meet 10 CFR Part 52 requirements. FSAR Tier 2, Section 9.5.4.5, "Inspection and Testing Requirements," states that the DGFOSTS is initially tested using the program detailed in FSAR Tier 2, Chapter 14, "Verification Programs," and FSAR Tier 2, Section 14.2, Test No. 104, "Emergency Diesel Generator Set," Test No. 105, "Emergency Diesel Generator Electrical Test," and Test No. 106, "Emergency Diesel Generator Auxiliaries." The operability of the system is checked by periodic testing and inspection of the complete EDG system. This test demonstrates the performance, structural, and leak-tight integrity of each system component.

SRP Section 9.5.4, Paragraph 9.5.4 I.1.I states that an applicant should identify the available and acceptable sources of fuel oil, including the means of transporting oil and recharging the fuel oil storage tank, following a DBA and LOOP to enable each redundant diesel generator system to supply uninterrupted emergency power for as long as required. The FSAR includes COL Information Item No. 9.5-22 in FSAR Tier 2, Table 1.8-2 and Section 9.5.4 as follows:

> A COL applicant that references the U.S. EPR design certification will describe the site specific sources of acceptable fuel oil available for refilling the EDG fuel oil storage tanks within seven days, including the means of transporting and refilling the fuel oil storage tanks, following a design basis event to enable each diesel generator system to supply uninterrupted emergency power.

SRP Section 9.5.4, Paragraph 9.5.4.III.6.A specifies that each fuel oil storage tank has a stick gauge connection for determining its fuel level. In RAI 251, Question 09.05.04-20, the staff requested that the applicant verify that each storage tank has a stick gauge connection for determining its fuel level. The staff also suggested that the FSAR be revised to reflect this information. In a July 24, 2009, response to RAI 251, Question 09.05.04-20, the applicant noted that a stick gauge is not practical for an indoor, aboveground tank and that the U.S. EPR design provides the tank level measurement function using non-intrusive level instrumentation which eliminates the potential for foreign material contamination associated with open tank verification. The storage tanks are equipped with electronic measurement instrumentation that provides local and remote indication of the oil level in the tanks. In addition, the tanks are provided with independent visual level indication for local monitoring of tank level. The staff finds that this design is an acceptable alternative to the SRP guidance.

<u>Fuel Oil Chemistry Aspects</u>

The diesel engine fuel oil storage and transfer system (DGFOSTS) provides for storage and transfer of fuel oil to the emergency diesels. There is an independent DGFOSTS for each emergency diesel. Each system consists of a main fuel oil storage tank, two electrically driven fuel oil transfer pumps, fuel oil day tank, engine-driven fuel oil pump, auxiliary fuel oil pump, strainers, filters, and monitoring systems.

The staff reviewed the diesel engine fuel oil storage and transfer system in accordance with NUREG-0800, Section 9.5.4, "Emergency Diesel Engine Fuel Oil Storage and Transfer System," Revision 3, March 2007, with regard to fuel oil quality and testing. Staff acceptance of the design is based on meeting the requirements of GDC 17 and the guidelines in RG 1.137, Regulatory Position C.2.

The staff reviewed the requirements of GDC 17 and guidelines of RG 1.137, Regulatory Position C.2 against FSAR Tier 2, Section 9.5.4, "Diesel Engine Fuel Oil Storage and Transfer System," FSAR Tier 2, Chapter 16, Sections 3.8.3, "Technical Specifications – Diesel Fuel Oil, Lube Oil and Starting Air," and B.3.8.3, "Technical Specification Basis – Diesel Fuel Oil, Lube Oil and Starting Air."

RG 1.137 endorsed ANSI N195-1976/ANS 59.51, "Fuel Oil Systems for Standby Diesel-Generators," as providing an acceptable method for complying with the pertinent requirements of GDC 17, subject to some clarifications and additional requirements. Subsequent revisions to ANSI 59.51, "Fuel Oil Systems for Safety-Related Emergency Diesel-Generators," considered and incorporated these clarifications and requirements where appropriate.

FSAR Tier 2, Section 9.5.4.3.1 states the minimum fuel quality defined by RG 1.137 and incorporated in the fuel testing program must be met prior to adding new fuel to the storage tanks.

FSAR Tier 2, Chapter 16, Section 3.8.3, Surveillance Requirement 3.8.3.3 requires the testing of new and stored fuel in accordance with the Diesel Fuel Oil Testing Program.

The Diesel Fuel Oil Testing Program described in FSAR Tier 2, Chapter 16, Section 5.5.12 requires testing of new and stored fuel to applicable American Society for Testing and Materials (ASTM) standards. The program requires determining the acceptability of new fuel prior to addition to the storage tanks by determining that the new fuel oil has the following:

- An American Petroleum Institute (API) gravity or an absolute specific gravity within limits.
- A flashpoint and kinematic viscosity within limits for ASTM 2D fuel oil.
- A clear and bright appearance with proper color, or a water and sediment content within limits.
- Within 31 days following addition of the new fuel oil to storage tanks, the remaining properties of the new fuel oil are within the limits for ASTM 2D fuel oil.
- Total particulate concentration of the fuel oil is $\leq$ 10mg/l (10ppm) when tested every 31 days

FSAR Tier 2, Chapter 16, Section B3.8.3, SR 3.8.3.3 requires that tests are conducted prior to adding new fuel to the storage tanks, but, in no case, is the time to exceed 31 days between fuel receipt and testing. Sampling is in accordance with ASTM D4057-R2000, "Practice or Manual Sampling of Petroleum and Petroleum Products." Fuel testing includes tests specified in various ASTM standards as follows:

- An absolute specific gravity at (60/60 °F) (15.5/15.5 °C) of $\geq$ 0.83 and $\leq$ 0.89 or an API gravity at 15.5 °C (60 °F) of $\geq$ 27° and $\leq$ 39° when tested in accordance with ASTM D1288-1999 R2005, "Standard Test Method for Density, Relative Density (Specific Gravity), or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method"
- A kinematic viscosity at 40 °C (104 °F) of $\geq$1.9 mm^2/s (1.9 centistokes) and $\leq$ 4.1 mm^2/s (4.1 centistokes) when tested in accordance with D975-2006, "Standard Specification for Diesel Fuel Oils"

- A flash point of ≥52 °C (125 °F) when tested in accordance with D975-2006, “Standard Specification for Diesel Fuel Oils”

- The new fuel oil has a clear and bright appearance with proper color when tested in accordance with ASTM D4176-2004 E2005, “Standard Test Method for Free Water and Particulate Contamination in Distillate Fuels (Visual Inspection Procedures),” or a water and sediment content within limits when tested in accordance with ASTM D2709-1995 R2006, “Standard Test Method for Water and Sediment in Middle Distillate Fuels by Centrifuge”

The above parameters comply with the ASTM D975 Table 1 limits for ASTM No. 2D fuel oil and are thus, acceptable.

Additionally, within 31 days, the new fuel oil sample must be analyzed to verify the other properties in ASTM D975-2006, Table 1 are met.

The new fuel testing specified by the applicant complies with the recommendations of RG 1.137 with the following exceptions.

RG 1.137, Regulatory Position C.2 requires the cloud point to be less than or equal to the 3-hour minimum soak temperature or the minimum temperature at which the fuel oil is stored. The Diesel Fuel Oil Testing Program does not specify minimum cloud point temperature even though the main tank room of the Emergency Power Generating Building has a design minimum temperature of 15 °C (59 °F) (FSAR Tier 2, Section 9.4.9.1). Therefore, in RAI 200, Question 09.05.04-17, the staff requested that the applicant provide a COL item to specify the cloud point of the diesel fuel oil. In an April 24, 2009, response to RAI 200, Question 09.05.04-17, the applicant stated that the requirements for information regarding the purchasing requirements for diesel fuel oil would be addressed as part of COL Information Item 13.5-1.

> A COL applicant that references the U.S. EPR design certification will provide site-specific information for administrative, operating, emergency, maintenance and other operating procedures.

The staff finds the applicant’s April 24 2009, response to RAI 200, Question 09.05.04-17, acceptable and consider this question resolved.

RG 1.137, Regulatory Position C.2.b recommends testing should be completed within 2 weeks of the addition instead of the Technical Specification duration of 31 days. The applicant states that the 31-day period is acceptable, since the fuel oil properties of interest do not have an immediate impact on diesel operation. The staff finds this justification acceptable.

Particulate concentration is determined in accordance with ASTM D5452-2005, “Standard Test Method for Particulate Contamination in Aviation Fuels by Laboratory Filtration,” every 31 days on stored fuel. Maximum particulate concentration is 10 mg/l(10 ppm), which complies with the ANSI 59.51 requirement.

RG 1.137, Regulatory Position C.2.a recommends that fuel contained in a supply tank not meeting the applicable specification requirements should be replaced in a short period of time (about a week). If new fuel properties are not within limits, Limiting Condition for Operation (LCO) 3.8.3 d requires restoring the stored fuel to within limits within 30 days, or the associated emergency diesel is declared inoperable. Therefore, in RAI 86, Question 09.05.04-2, the staff requested that the applicant clarify this issue. In a November 3, 2008, response to RAI 86, Question 09.05.04-2, the applicant clarified that the Technical Specification Bases 3.8.3 D.1 states:

> Within the new fuel oil properties defined in the Bases for SR 3.8.3.3 not within the required limits, a period of 30 days is allowed for restoring the stored fuel oil properties. This period provides sufficient time to rest the stored fuel oil to determine that the new fuel oil, when mixed with the previously stored fuel oil, remains acceptable, or to restore the stored fuel oil properties. This restoration may involve feed and bleed procedures, filtering, or combinations of these procedures. Even if an EDG start and load was required during this time interval and the fuel oil properties were outside limits, there is a high likelihood that the EDG would still be capable of performing its intended function.

The staff finds that Technical Specification Bases 3.8.3 D.1 provides adequate justification for extending the LCO period to 30 days. The staff considers RAI 86, Question 09.05.04-2 resolved.

RG 1.137, Regulatory Position C.2.a recommends that, in the event that tests for viscosity or for water and sediment for fuel oil contained in the supply tanks exceed specified limits, the associated diesel should be declared inoperable. Technical Specification 3.8.3 C.1 only enters an LCO if particulate values exceed the limit. ASTM D975-2008a, Appendix X2, “Storage and Thermal Stability of Diesel Fuels,” paragraph X3.6.2 indicates that fuel oil degradation products and fuel contaminants will usually settle to the bottom of a quiescent tank. The staff finds it acceptable to monitoring particulate concentration only if the measured particulate limit exceeds 10 mg/l (10 ppm), Technical Specification 3.8.3. C.1 requires that the total particulates must be restored to within limits or the associated diesel is declared inoperable after 7 days. The 7-day completion time allows for further evaluation, re-sampling, and re-analysis of the fuel oil. The staff finds this acceptable.

RG 1.137, Regulatory Position C.2.d recommends the draining of accumulated condensate from storage tanks quarterly; Surveillance Requirement SR 3.8.3.5 requires draining condensate from storage tanks every 92 days; however RG 1.137 recommends checking the tanks monthly. In RAI 200, Question 09.05.04-18, the staff requested that the applicant provide justification for the extended interval. In an April 24, 2009 response to RAI 200, Question 09.05.04-18, the applicant stated the design of the DGFOSTS, which includes locating the storage tanks in the EPGB, minimizes the opportunity for water intrusion into the fuel oil storage tank from groundwater or rainwater. Additionally, the emergency power generating building ventilation system (EPGBVS) maintains acceptable ambient conditions to minimize the opportunity for water intrusion into the fuel oil storage tank or day tank due to condensation. The staff finds this justification acceptable and considers RAI 200, Question 09.05.04-18 resolved.

The main fuel oil tank design incorporates a low point sump to accumulate water and sediment. The fill line and transfer suction lines are located above the sump to preclude disturbance of the sediment and water, which could lead to reducing the overall quality of the fuel. The staff finds this satisfies RG 1.137, Regulatory Position C.2.h. RG 1.137, Regulatory Position C.2.f recommends draining, removing accumulated sediment, and cleaning the fuel oil storage tanks every 10 years. In a November 3, 2008, response to RAI 86, Question 09.05.04-5, the applicant stated that tank cleaning is a preventative maintenance item and need not be tracked by the FSAR. The staff agrees with the applicant’s response and considers this question closed.

The main fuel oil storage tanks are located in the main tank room of the Emergency Power Generating Building; RG 1.137, Regulatory Position C.2.h is not applicable, since it applies to buried tanks.

The proposed Diesel Fuel Oil Testing Program is generally consistent with the guidance in RG 1.137, Regulatory Position C.2 as recommended in SRP Section 9.5.4, with appropriate justification for the deviations from this guidance. Therefore, the staff concludes the diesel engine fuel oil quality and testing program meets the requirements of GDC 17.

9.5.4.5 *Combined License Information Items*

Table 9.5.4-1 provides a list of diesel fuel oil storage and transfer system related COL information item numbers and descriptions from FSAR Tier 2, Table 1.8-2:

Table 9.5.4-1 U.S. EPR Combined License Information Items

Item No.	Description	FSAR Tier 2 Section
9.5.4-22	A COL applicant that references the U.S. EPR design certification will describe the site-specific sources of acceptable fuel oil available for refilling the EDG fuel oil storage tanks within seven days, including the means of transporting and refilling the fuel oil storage tanks, following a design basis event to enable each diesel generator system to supply uninterrupted emergency power	9.5.4.4

The staff finds the above listing to be complete. Also, the list adequately describes actions necessary for the COL applicant or holder. No additional COL information items need to be included in FSAR Tier 2, Table 1.8-2 for DGFOSTS consideration.

9.5.4.6 *Conclusions*

Mechanical System Aspects

The staff concludes that the DGFOSTS mechanical design is acceptable and complies with regulations as stated in the general design criteria of 10 CFR Part 50, Appendix A. This conclusion is based on the technical evaluation that determined the FSAR meets GDC 2, GDC 4, GDC 5, GDC 17, and 10 CFR 52.47(b)(1).

Fuel Oil Chemistry Aspects

The staff concludes the diesel engine fuel oil storage and transfer system meets the requirements of GDC 17 and the guidelines of SRP Section 9.5.4 with respect to fuel oil quality and testing.

9.5.5 Diesel Generator Cooling Water System

9.5.5.1 *Introduction*

The review of the U.S. EPR Class 1E emergency diesel generator cooling water system (DGCWS) is to assure compliance of the system design with the requirements of GDC 2, GDC 4, GDC 5, GDC 17, GDC 44, “Cooling Water,” GDC 45, “Inspection of Cooling Water System,” and GDC 46, “Testing of Cooling Water System,” and 10 CFR 52.47(b)(1). EDG cooling is provided to the engine components and to the EDG turbo-charger. Heat is dissipated from the crankcase, cylinder heads, governor oil, lubricating oil, and generator bearings. The DGCWS also supplies preheating to establish quick-start capability. Each EDG has a separate and independent cooling water system.

9.5.5.2 *Summary of Application*

FSAR Tier 1: The FSAR Tier 1, Section 2.5.4, describes the principal performance characteristics and safety functions of the emergency diesel generators and their supporting equipment, including Table 2.5.4-1, Table 2.5.4-2, Table 2.5.4-3, Table 2.5.4-4, and Figure 2.5.4-4, “Emergency Diesel Generator Cooling Water System Functional Arrangement.” FSAR Tier 1, Section 2.5.4, Item 6.6, states that the EDG cooling water system heat exchangers have the capacity to transfer the design heat load to the essential service water system. Other items in this section state the design requirements for the ASME Section III and Seismic Category I portions of all of the EDG support systems.

FSAR Tier 2: The applicant has provided a system description in FSAR Tier 2, Section 9.5.5, “Diesel Generator Cooling Water System,” summarized here, in part, as follows:

Each EDG has its own dedicated and independent cooling water system as described in FSAR Tier 2, Section 9.5.5. Each system is comprised of a preheater system (preheater, pump, and temperature regulating valve), a jacket water cooling water system (pump, heat exchanger, and temperature regulating valve), an intercooler cooling water system (pump, heat exchanger, and temperature regulating valve), and a cooling system expansion tank.

Each EDG is provided with sufficient instrumentation to monitor the operation of the DGCWS. During periodic testing, the engine is stopped in case of low-low level or high temperature of the cooling water. However, during emergency operations, the EDG will only trip on complete loss of cooling water flow or high-high jacket water temperature or complete loss of ESWS cooling water. The latter is determined by a loss of pressure in the ESWS system and during LOOP condition the EDG trip signal will be delayed by 2 minutes to allow ESWS system flow to be re-established.

ITAAC: FSAR Tier 1, Table 2.5.4-4, provides inspections, tests, analyses, and acceptance criteria requirements for the EDGs. Item 2.6 of Table 2.5.4-4 requires verification of the functional arrangement of the EDG cooling water system. Table 2.5.4-4 provides specific requirements for the DGCWS heat exchangers (Item 6.6). In addition, there are other ITAAC that apply generally to all of the EDG support systems, including Items 2.2, 3.7, 3.13, 3.16 through 3.24, 4.1, 4.2, 4.3, 5.2, 5.4, and 6.5.

Technical Specifications: FSAR Tier 2, Chapter 16, TS 3.8.1 through TS 3.8.5, “DC sources - Shutdown,” provides EDG requirements. There are no specific TS requirements for the cooling water system. Cooling water system requirements are implied with overall EDG operability.

9.5.5.3 *Regulatory Basis*

The relevant requirements of NRC regulations for this area of review, and the associated acceptance criteria, are specified in NUREG-0800, Section 9.5.5, "Emergency Diesel Engine Cooling Water System," and are summarized below. Other areas of review (other SRP sections) that include interfaces with this SRP section are identified in NUREG-0800, Section 9.5.5.

1. GDC 2, as it relates to SSCs important to safety that must be protected from, or capable of withstanding, the effects of such natural phenomena as earthquakes, tornadoes, hurricanes, and floods as described in FSAR Chapters 2 and 3.

2. GDC 4, as it relates to SSCs important to safety that must be protected from, or capable of withstanding, the effects of externally generated missiles, internally generated missiles, pipe whip, and jet impingement forces associated with pipe breaks.

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

4. GDC 17, as it relates to the capability of the DGCWS to support the requirement for independence, redundancy and testability of the onsite electric power system to assure post-accident safe shutdown.

5. GDC 44, as it relates to capabilities of the DGCWS with suitable redundancy to transfer heat from engine components to an ultimate heat sink under transient or accident conditions.

6. GDC 45, as it relates to design provisions to permit appropriate periodic inspections of important DGCWS components to assure the integrity and capability of the system.

7. GDC 46, as it relates to design provisions to permit appropriate periodic pressure and functional testing of the DGCWS to assure the structural integrity and leak tightness of its components, the operability and performance of active components, and the operability of the system as a whole and, under conditions as close to design as practical for reactor shutdown and for loss-of-coolant accidents.

8. 10 CFR 52.47(b)(1) which requires that a U.S. EPR application contain the proposed ITAAC that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a plant that incorporates the design certification is built and will operate in accordance with the design certification, the provisions of the Atomic Energy Act of 1954, and NRC regulations.

Acceptance criteria adequate to meet the above requirements include:

1. RG 1.26 provides guidance for the appropriate quality group classification of system components.

2. RG 1.29 provides guidance for the appropriate seismic classification of system SSCs.

3. NUREG/CR-0660 provides guidance based on operating experience with EDGs.

Also, each EDG should have an independent and dedicated cooling water system and should have the capability to dissipate heat as needed to the ultimate heat sink under transient and accident conditions.

9.5.5.4 *Technical Evaluation*

The staff reviewed the design description of the DGCWS in the FSAR in accordance with NUREG-0800, Section 9.5.5.

FSAR Tier 2, Section 9.5.5 describes the DGCWS. The U.S. EPR has four EDGs. Each EDG has a separate and independent DGCWS. The DGCWS is divided into safety-related and non-safety-related portions. The non-safety-related portions are provided for preheating and are active during engine shutdown. The safety-related portions are provided for engine cooling and are active during engine operation. The safety-related portions are further divided into two subsystems, jacket water cooling and intercooler cooling. The two subsystems share a common expansion tank, but otherwise operate independent of each other. The jacket water system is shown on Sheet 1 of FSAR Tier 2, Figure 9.5.5-1, “Emergency Diesel Generator Cooling Water System.” It removes heat from the engine cylinder heads and crankcase, and contains an engine driven pump, a jacket-water heat exchanger, and a temperature-controlled thermostatic bypass valve. The intercooler system is shown on Sheet 2 of FSAR Tier 2, Figure 9.5.5-1. It removes heat from the engine turbocharger, governor oil, and generator oil and also contains an engine driven pump, a heat exchanger, and a thermostatic bypass valve. The bypass valves maintain jacket-water and intercooler temperatures within their normal operating ranges by bypassing the heat exchangers as needed based upon engine load and cooling water inlet temperature.

In accordance with the guidance in RG 1.26 and RG 1.29, each DGCWS, except the jacket water standby heater circuit, is classified as safety related, Quality Group C, ASME Section III Class 3, and Seismic Category I as shown in FSAR Tier 1, Table 2.5.4-1 and Table 2.5.4-2, and FSAR Tier 2, Table 3.2.2-1. The jacket water standby heater circuit is not required to function during a seismic event and is classified supplemented grade (NS-AQ) and Quality Group D. Since the jacket water standby heater circuit is directly connected to the safety-related, Seismic Category I section of the DGCWS, the standby heater circuit is Seismic Category II so that its failure will not adversely affect the Seismic Category I system.

The portions of the cooling system that are part of the engine assembly are Seismic Category I but are not within the ASME Section III boundary; therefore, the quality group classifications for these SSCs are Quality Group E. The non-fluid-containing components of the system do not have a quality group classification, since RG 1.26 only pertains to water and steam containing components.

The DGCWS SSCs important to safety are Seismic Category I and thus meet RG 1.29, Regulatory Position C.1. FSAR Tier 2, Section 9.5.5.4, “Safety Evaluation,” and FSAR Tier 2, Figure 9.5.5-1 state that each DGCWS is located in the EPGB for each emergency power division. The cooling water heat exchangers are installed in the EPGB and are structurally protected against environmental impacts. Each EPGB is a safety-related, Seismic Category I building, which is designed to withstand the effects of natural phenomena including earthquakes, tornadoes, hurricanes, floods, and external missiles. Thus, the DGCWS SSCs important to safety are protected from natural phenomena. Non-Seismic Category I SSCs in surrounding SSCs will either have no effect on the DGCWS after an SSE or are classified as Seismic Category II. Therefore, the staff finds that the DGCWS meets the requirements of GDC 2.

Since each EDG is located in a dedicated EPGB room and each of the four divisions is separate and independent from one another, a failure of any pressure line has the potential to affect only the function of SSCs in that division. There are no high- or moderate-energy lines in the EPGB whose failure can affect the function of more than one DGCWS. Therefore, the staff finds that the DGCWS meets the requirements of GDC 4.

The U.S. EPR is a single-unit design. The U.S. EPR has four independent EDGs, each with a separate and independent DGCWS that is not shared with other diesel generators or other nuclear units. Therefore, the staff finds that the DGCWS meets the requirements of GDC 5.

SRP Section 9.5.5 lists other guidelines for the applicant to meet the requirements of GDC 17. The applicant has met these guidelines as follows. Each EDG has a separate and independent DGCWS. The recommendations of NUREG/CR-0660 have been met in that three-way thermostatic valves are used to direct engine water to the bypass or cooler as required. In addition, EDG controls and monitoring displays are located in the EDG control room and are, therefore, removed from the heat and vibration of the engine. Sensors and limited local instrumentation that remain on the engine and skid are selected and qualified for the local environment and are appropriately mounted with isolation for vibration where required. Vibration issues with instrumentation and controls of the EDG are addressed in FSAR Tier 2, Section 8.3.1.1.5, “Standby AC Emergency Diesel Generators,” which states:

> Local instrument panels in the diesel rooms at the engine are isolated from engine vibration.

System capability is tested each time the EDG is operated. System operating parameters are monitored and an unacceptable reduction in capability will be alarmed.

The DGCWS design features, including redundancy and independence, and the provisions for testing the system capability support the requirement for an onsite electric power system to assure post-accident safe shutdown and, therefore, meet the requirements of GDC 17.

SRP Section 9.5.5 lists the guidelines for the applicant to meet the requirements of GDC 44. The staff has determined that the applicant has met these guidelines. The application states that each DGCWS has a jacket water heat exchanger and an intercooler heat exchanger cooled by essential service water which transfers heat under transient and accident conditions. Each EDG has an independent and separate DGCWS, such that a single active component failure will not result in a loss of more than one EDG, allowing unaffected EDGs to perform system safety functions. Therefore, the staff concludes that the DGCWS meets GDC 44.

SRP Section 9.5.5 lists the guidelines for the applicant to meet the requirements of GDC 45. The staff has determined that the applicant has met these guidelines, since the FSAR states that the layout of the piping and main components (i.e., expansion tank, heat exchangers, pumps, and valves) provides the space required to permit routine inspections, cleaning, and maintenance. Therefore, the staff concludes that the DGCWS meets GDC 45.

SRP Section 9.5.5 lists the guidelines for the applicant to meet the requirements of GDC 46. The staff has determined that the applicant has met these guidelines, since the application states that active components are capable of being tested during plant operation, provisions are made to allow for inservice inspection of components, and the DGCWS is tested periodically along with the complete EDG system. These tests demonstrate the performance, structural, and leak tightness requirements of each system component. Therefore, the staff concludes that the DGCWS meets GDC 46.

The applicant has met the other guidelines of SRP Section 9.5.5 as follows:

FSAR Tier 2, Section 9.5.5 states that no single failure will compromise the EDG safety functions, since the U.S. EPR contains four separate and independent EDGs. Cooling water systems are not shared between diesel generators and are not shared between nuclear units.

The DGCWS expansion tank compensates for differences in coolant volume due to thermal expansion. The tank is located at the highest point of the DGCWS cooling system, and the tank level is monitored and alarmed. The tank provides sufficient reserve capacity for operation of the EDG at continuous rating for at least 7 days with normal anticipated minor water loss.

During normal operations, the EDG is stopped by low-low level in the cooling water expansion tank or high cooling water temperature. Under emergency conditions, low ESWS flow is alarmed and the EDG is tripped on complete loss of the ESWS. The trip is delayed for 2 minutes during a loss of offsite power event to permit time to re-establish ESWS flow. High jacket water temperature is alarmed, and the EDG trips on high-high jacket water temperature in all EDG operating modes.

FSAR Tier 2, Section 9.5.5.3.1, "Normal Operation," states that operating procedures require engine loading up to 50 percent load for 30 minutes after 4 hours of continuous operation at no or light loads (less than 30 percent), or as recommended by the manufacturer.

System materials, water quality, and flow rates are designed to minimize corrosion and system deposits. Water chemistry is controlled based upon EDG vendor recommendations. If needed, corrosion inhibitor, biocide, or antifreeze may be added to cooling water to preclude fouling or corrosion.

SRP Section 9.5.5 specifies that the design include the capability to detect and control system leakage, including isolating system portions in the event of excessive leakage or component malfunction. EDG operation is monitored by local operators that routinely observe the equipment for abnormal operating conditions, including leaks. Also, the system is equipped with isolation valves on all branch lines such that leaks in those lines can be isolated without affecting the operability of the DGCWS. During unattended operation, a leak in the DGCWS results in a low level in the DGCWS expansion tank, which actuates the low level alarm and the demineralized water system fill valve which provides makeup to the tank.

The FSAR also states that in the event that the demineralized water system is unavailable, there is a manual fill port on the tank that is used by operators to fill the tank from an alternate source. If the leak is from a DGCWS component required for EDG operation and is greater than that which can be maintained through normal or alternate fill provisions, the EDG would be shut down by the operators or will trip on high-high water temperature if system water loss reaches the point where cooling capability is compromised.

There are no Technical Specifications associated with the DGCWS. The staff finds this in conformance with NUREG-1431, Vol. 1, "Standard Technical Specifications — Westinghouse Plants."

FSAR Tier 1, Section 2.5.4 and Table 2.5.4-4, Item 6.6, provides an ITAAC for the DGCWS to verify that the EDG cooling water system heat exchangers have the capacity to transfer the design heat load to the essential service water system. In addition to these confirmations, other items of FSAR Tier 1, Section 2.5.4, Table 2.5.4-4 will confirm the configuration, location, and safety classifications of the DGCWS.

FSAR Tier 2, Section 9.5.5.5, "Inspection and Testing Requirements," states that the DGCWS is initially tested using the program detailed in FSAR Tier 2, Section 14.2, Test No. 104, "Emergency Diesel Generator Set," Test No. 105, "Emergency Diesel Generator Electrical Test," and Test No. 106, "Emergency Diesel Generator Auxiliaries." The operability of the system is checked by periodic testing and inspection of the complete EDG system. This testing demonstrates the performance, structural, and leak-tight integrity of each system component.

9.5.5.5 *Combined License Information Items*

No applicable items were identified in the FSAR. No additional COL information items need to be included in FSAR Tier 2, Table 1.8-2 for DGCWS consideration.

9.5.5.6 *Conclusions*

The staff concludes that, the DGCWS design is acceptable and complies with the regulations as stated in the general design criteria of Appendix A to 10 CFR Part 50. This conclusion is based on the technical evaluation that the FSAR meets the requirements of GDC 2, GDC 4, GDC 5, GDC 17, GDC 44, GDC 45, and GDC 46 and 10 CFR 52.47(b)(1) for the DGCWS.

9.5.6 Diesel Generator Starting Air System

9.5.6.1 *Introduction*

The review of the U.S. EPR Class 1E emergency diesel generator starting air system (DGSAS) is to assure compliance of the system design with the requirements of GDC 2, GDC 4, GDC 5, and GDC 17 and 10 CFR 52.47(b)(1). The EDGs are started by compressed air which rotates the engine until fuel combustion begins and accelerates engine speed on its own. The DGSAS is divided into two parts. The air receiver tanks and the piping and components downstream of the tanks are safety-related. The remainder of the system, specifically the part of the system that refills the air receiver tanks, is non-safety-related. The safety-related portion of the DGSAS stores sufficient air capacity for five consecutive engine starts. Each EDG has a separate and independent DGSAS.

9.5.6.2 *Summary of Application*

FSAR Tier 1: FSAR Tier 1, Section 2.5.4 describes the principal performance characteristics and safety functions of the emergency diesel generators and their supporting equipment, and includes Table 2.5.4-1, Table 2.5.4-2, Table 2.5.4-3, Table 2.5.4-4, and Figure 2.5.4-5, "Emergency Diesel Generator Starting Air System Functional Arrangement." FSAR Tier 1, Section 2.5.4, Item 3.12 states that each EDG starting air system is capable of providing air to start the respective EDG without being recharged. Other items in this section state the design requirements for the ASME Section III and Seismic Category I portions of all of the EDG support systems.

FSAR Tier 2: The applicant has provided a system description in FSAR Tier 2, Section 9.5.6, "Diesel Generator Starting Air System," summarized here in part, as follows:

Each EDG has its own dedicated and independent DGSAS as described in FSAR Tier 2, Section 9.5.6. Each system contains two compressors, two air dryers, two air receivers, and associated piping, valves, controls, and instruments. Each engine has its own air-start distributor with a pilot air connection to each cylinder for operating starting air valves. The safety-related air receiver inlet check valves provide isolation between the non-safety-related and safety-related portions of the system. Starting air pressure is also used to open fuel injector pump racks to provide adequate fuel for startup. For emergency shutdown of the engine, the governor shutdown solenoid valve operates to cause the governor to close the fuel racks.

ITAAC: FSAR Tier 1, Table 2.5.4-4, provides ITAAC requirements for the EDGs. Item 2.7 of Table 2.5.4-4 requires verification of the functional arrangement of the DGSAS. Table 2.5.4-4 provides specific requirements for the starting air receivers (Item 3.12). In addition to these ITAAC that are specifically for the DGSAS, there are other ITAAC that apply generally to all of the EDG support systems, including Items 2.2, 3.7, 3.13, 3.16 through 3.24, 4.1, 4.2, 4.3, 5.2, 5.4, and 6.5.

Technical Specifications: FSAR Tier 2, Chapter 16, TS 3.8.1 provides EDG requirements. Limiting Conditions for Operation for the DGSAS are given in TS 3.8.3.

9.5.6.3 *Regulatory Basis*

The relevant requirements of NRC regulations for this area of review, and the associated acceptance criteria, are specified in NUREG-0800, Section 9.5.6, "Emergency Diesel Engine Starting System," and are summarized below. Other areas of review (other SRP sections) that include interfaces with this SRP section are identified in NUREG-0800, Section 9.5.6.

1. GDC 2, as it relates to SSCs important to safety that must be protected from, or capable of withstanding, the effects of such natural phenomena as earthquakes, tornadoes, hurricanes, and floods as described in FSAR Chapters 2 and 3.

2. GDC 4, as it relates to SSCs important to safety that must be protected from, or capable of withstanding, the effects of externally generated missiles, internally generated missiles, pipe whip, and jet impingement forces associated with pipe breaks.

3. GDC 5, as it relates to the capability of shared systems and components important to safety to perform required DGSAS safety functions.

4. GDC 17, as it relates to the capability of the DGSAS to support the requirement for independence, redundancy and testability of the onsite electric power system to assure post-accident safe shutdown.

5. 10 CFR 52.47(b)(1), which requires that a U.S. EPR application contain the proposed ITAAC that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a plant that incorporates the design certification is built and will operate in accordance with the design certification, the provisions of the Atomic Energy Act of 1954, and NRC regulations.

Acceptance criteria adequate to meet the above requirements include:

1. RG 1.26 provides guidance for the appropriate quality group classification of system components.

2. RG 1.29 provides guidance for the appropriate seismic classification of system SSCs.

3. NUREG/CR-0660 provides guidance that supports compliance with GDC 17. Also, each EDG should have a dedicated starting air system consisting of a compressor, an air dryer, and one or more receivers as recommended by the engine manufacturer. Capability should be provided to crank a cold EDG five times without recharging receivers.

9.5.6.4 *Technical Evaluation*

The staff reviewed the design description of the DGSAS in the FSAR for the U.S. EPR in accordance with NUREG-0800, Section 9.5.6.

FSAR Tier 2, Section 9.5.6 describes the DGSAS. The U.S. EPR has four EDGs. Each EDG has its own dedicated and independent DGSAS. Each DGSAS consists of two compressors, two air dryers and filters, two air receivers, and associated piping, valves, controls, and instruments. Starting air pressure is also used to open fuel injector pump racks to provide adequate fuel for startup. Since each EDG is supplied with a dedicated and independent DGSAS and starting air systems are not shared between nuclear power units, the requirements of GDC 5 are met.

The air compressors are electric-motor driven with power from the switchgear of the associated EDG. The compressors contain air intake filters and an intercooler. The intercooler contains an automatic blowdown device to reduce moisture. Compressors start and stop automatically based on air receiver pressure. The compressors are non-safety-related, with one designated as primary and one designated as secondary. The secondary compressor starts on falling receiver pressure if the primary compressor fails to start.

For normal operations, ambient air is taken from the engine room, compressed, dried, filtered, and stored in air receiver tanks. The starting air receivers are tanks with capacity for five start attempts of the EDG after the low-pressure alarm set-point has been reached. A start cycle is defined as a minimum of 3 sec. of air admission resulting in at least two to three revolutions of the engine. Each air compressor is sized to recharge the air receivers within 30 min. following the consumption of air used for 5 start attempts. Safety relief valves are provided for receiver over-pressure protection. The portion of the system from, and including, the air receiver inlet check valve, through the air receiver and discharge piping up to the connection at the engine interface, is safety-related as shown in FSAR Tier 2, Figure 9.5.6-1, "Emergency Diesel Generator Starting Air System."

In accordance with RG 1.26 and RG 1.29, the safety-related portion of each DGSAS is classified as Quality Group C, ASME Section III Class 3, and Seismic Category I as shown in FSAR Tier 1, Table 2.5.4-1, and FSAR Tier 2, Table 3.2.2-1. The air compressors and the portion of the DGSAS up to the air receiver inlet check valves are non-safety-related, Quality Group D, and Seismic Category II. The portions of the DGSAS that are part of the engine assembly are Seismic Category I but are not within the ASME Section III boundary; therefore, the quality group classification for these SSCs is Quality Group E. The non-fluid-containing components of the system do not have a quality group classification, since RG 1.26 only pertains to water and steam containing components.

Each DGSAS is located in the EPGB for each emergency power division. Each EPGB is a safety-related, Seismic Category I building, which is designed to withstand the effects of natural phenomena including earthquakes, tornadoes, hurricanes, floods, and external missiles, as described in FSAR Tier 2, Sections 3.3, "Wind and Tornado Loadings," to 3.8, "Design of Category I Structures." Thus, the DGSAS SSCs important to safety are protected from natural phenomena. The non-safety-related SSCs, both in the DGSAS and in surrounding SSCs, that could potentially damage safety-related SSCs in the event of a design basis earthquake are designed as Seismic Category II to withstand SSE seismic loads without incurring a structural failure that permits deleterious interaction with the safety-related portions of the DGSAS. Therefore, the staff finds that the DGSAS meets the requirements of GDC 2.

Each EDG division is located in a dedicated room in the EPGB, which contains support systems for that division. The four divisions are separate and independent from one another. All pressure lines located in a division support only that division. A failure of any pressure line will only have the potential to impact the function of the SSCs in that division. There are no high- or moderate-energy lines in the EPGB whose failure could alter the function of more than one DGSAS. Therefore, the staff finds that the DGSAS meets the requirements of GDC 4.

Each EDG has a dedicated DGSAS, with two air compressors, two air dryers, two filters, and two air receivers. Each DGSAS has the capability to cold crank the EDG as described above. Each air receiver has a pressure alarm, which alarms locally and in the main control room. Each air receiver is equipped with an automatic drain trap with a manual bypass for removing moisture. Starting air is dried to a dew point of not more than 10 °C (50 °F) when installed in a normally controlled 21.1 °C (70 °F) environment; otherwise at least 5.6 °C (10 °F) less than the lowest expected ambient temperature.

The DGSAS includes air dryers to remove entrained moisture, and filters to remove contaminants like rust and oil. The applicant has stated that the layout of the piping and main components (i.e., compressors, air dryers, air receivers, valves, and filters) provides the space required to permit inspection, cleaning, maintenance, and repair of the system.

The DGSAS design includes the capability to detect and control leakage, including isolation of portions of the system for excessive leakage or component malfunction. The system incorporates welded and flanged connections, and minimizes the use of threaded connections in system piping and components. Manual valves are included to allow isolation of non-essential portions of the system in the event of leaks. In addition, the system is monitored and alarms are provided to identify system leakage.

FSAR Tier 2, Chapter 16, TS 3.8.3 provides limiting conditions of operation and surveillance requirements related to EDG starting air. Surveillance Requirement 3.8.3.4 requires each EDG air start receiver to be ≥3,100 kPa (≥435 psig). Paragraph E.1 of the bases for this requirement (B 3.8.3) states that sufficient air capacity for five consecutive starts is not available with receiver pressure <3,100 kPa (<435 psig), but that at least one start attempt is available with pressure >1,618 kPa (>220 psig) and that the EDG can be considered operable as long as the pressure is restored from >1,618 kPa (>220 psig) to >3,100 kPa (>435 psig) within 48 hrs.

FSAR Tier 2, Section 9.5.6.5, "Inspection and Testing Requirements," states that the DGSAS is initially tested using the program detailed in FSAR Tier 2, Chapter 14, and Section 14.2, Test No. 104, Test No. 105, and Test No. 106. The operability of the system is checked by periodic testing and inspection of the complete EDG system. This test demonstrates the performance, structural, and leak-tight integrity of each system component.

This testing also demonstrates operation of the starting air receiver volume for five consecutive starts; starting air compressors; starting air pneumatic controls; and starting air alarms, interlocks, and automatic operations.

Safety-related instrumentation and control functions are control air regulation using pressure reducing valves, emergency start using start solenoid valves, and governor boost using governor boost valves and actuator. Under emergency start conditions, alarm signals are provided in the main control room. Abnormal conditions are conditions in the EDG system that if left unattended could result in a catastrophic failure. Where a failure could jeopardize continued engine operation, a trip signal is activated. Other alarm conditions require operator action to determine if continued operation is feasible. Operators can activate a manual trip at any time. These conditions are monitored, and associated trip set-points are established to prevent operation of the EDG under circumstances where catastrophic failure is imminent. This action allows the conditions to be addressed and allows the equipment to be restored to service in a timely manner. The EDG emergency trips are given in FSAR Tier 2, Chapter 16, B 3.8.1, SR 3.8.1.13.

The DGSAS design features, including redundancy and independence, and the provisions for testing the system capability support the requirement for an onsite electric power system to assure post-accident safe shutdown and, therefore, meet the requirements of GDC 17.

9.5.6.5 *Combined License Information Items*

No applicable items were identified in the FSAR. No additional COL information items need to be included in FSAR Tier 2, Table 1.8-2 for DGSAS consideration.

9.5.6.6 *Conclusions*

The staff concludes that the DGSAS design is acceptable and complies with regulations as stated in the general design criteria of 10 CFR Part 50, Appendix A. This conclusion is based on the technical evaluation that determined the FSAR meets GDC 2, GDC 4, GDC 5, GDC 17, and 10 CFR 52.47(b)(1).

9.5.7 Diesel Generator Lubricating Oil System

9.5.7.1 *Introduction*

Each emergency diesel generator has a separate and independent diesel generator lubricating oil system (DGLS). Each system is comprised of safety-related components including engine-driven lube oil pump, thermostatic control valve, oil cooler, lube oil sump and tank storage, strainers, filters, and safety-relief valves. Each system also has a non-safety-related prelube pump and a keep-warm heater, which provides prelubrication flow to maintain the lube oil warm to facilitate quick starting, when required. The prelube and keep-warm equipment are off when the EDG is operating.

9.5.7.2 *Summary of Application*

FSAR Tier 1: The FSAR Tier 1, Section 2.5.4, describes the principal performance characteristics and safety functions of the emergency diesel generators and their supporting equipment, and includes Table 2.5.4-1, Table 2.5.4-2, Table 2.5.4-3, Table 2.5.4-4, and Figure 2.5.4-2, "Emergency Diesel Generator Lubricating Oil System Functional Arrangement." FSAR Tier 1, Section 2.5.4, Item 3.14 states that each DGLS provides lubrication to the engine and turbocharger wearing parts during engine operation. FSAR Tier 1, Section 2.5.4, Item 6.4 states that the EDG lubricating oil system heat exchangers have the capacity to transfer the design heat load to the essential service water system. Other items in this section state the design requirements for the ASME Section III and Seismic Category I portions of all of the EDG support systems.

FSAR Tier 2: The applicant has provided a system description in FSAR Tier 2, Section 9.5.7, "Emergency Diesel Engine Lubrication System," summarized here, in part, as follows:

Each EDG has its own dedicated and independent DGLS as described in FSAR Tier 2, Section 9.5.7. The system stores a minimum of 7 days of lubricating oil and delivers it to the EDG as required for continuous operation.

ITAAC: FSAR Tier 1, Table 2.5.4-4, provides ITAAC requirements for the EDGs. Item 2.4 of Table 2.5.4-4 requires verification of the functional arrangement of the DGLS. Table 2.5.4-4 provides specific requirements for the DGLS (Items 3.14 and 6.4). In addition to these ITAAC that are specifically for the DGLS, there are other ITAAC that apply generally to all of the EDG support systems, including Items 2.2, 3.7, 3.13, 3.16 through 3.24, 4.1, 4.2, 4.3, 5.2, 5.4, and 6.5.

Technical Specifications: FSAR Tier 2, Chapter 16, TS Section 3.8.1 provides EDG requirements. Surveillance Requirement 3.8.3.2 provides lube oil storage requirements. Limiting Condition for Operation for the lube oil storage requirement is given in TS 3.8.3.B.

9.5.7.3 *Regulatory Basis*

The relevant requirements of NRC regulations for this area of review, and the associated acceptance criteria, are specified in NUREG-0800, Section 9.5.7, "Emergency Diesel Engine Lubrication System," and are summarized below. Other areas of review (other SRP sections) that include interfaces with this SRP section are identified in NUREG-0800, Section 9.5.7.

1. GDC 2, as it relates to safety-related SSCs that must be protected from, or capable of withstanding, the effects of such natural phenomena as earthquakes, tornadoes, hurricanes, and floods as described in FSAR Chapters 2 and 3.

2. GDC 4, as it relates to safety-related SSCs that must be protected from, or capable of withstanding, the effects of externally generated missiles, internally generated missiles, pipe whip, and jet impingement forces associated with pipe breaks.

3. GDC 5, as it relates to the capability of shared systems and components important to safety to perform required DGLS safety functions.

4. GDC 17, as it relates to the capability of the DGLS to meet independence and redundancy criteria.

5. 10 CFR 52.47(b)(1), which requires that a U.S. EPR application contain the proposed ITAAC that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a plant that incorporates the design certification is built and will operate in accordance with the design certification, the provisions of the Atomic Energy Act of 1954, and NRC regulations.

Acceptance criteria adequate to meet the above requirements include:

- ANSI/ANS-59.52-1988, "Lubricating Oil Systems for Safety-Related Diesel Generators," regarding complete independence of other EDGs such that a single failure will not cause loss of required minimum EDG capacity for the site.

9.5.7.4 *Technical Evaluation*

The staff reviewed the U.S. EPR DGLS in accordance with NUREG-0800, Section 9.5.7, Revision 3. The staff's acceptance of the DGLS is based on the system design complying with the requirements of the GDC specified above.

FSAR Tier 2, Section 9.5.7 describes the DGLS. The system is located in the EPGB for each emergency power division and consists of a heat exchanger, an engine-driven lubrication pump, a keep-warm heater, an electric-driven prelubrication pump, thermostatic control valve, makeup tank, and associated piping, valves, filters, and instrumentation. During operation, the system draws lubricating oil from the EDG sump and delivers it through the heat exchanger and filters to the engine supply header. The header then supplies oil to both lubricate and cool various engine parts including bearings, crankshaft, turbocharger, and other moving parts of the engine. A pressure regulating valve maintains the system at constant pressure by recirculating some oil directly back to the engine-sump. When in the standby mode, the system maintains a minimum oil temperature and provides prelubrication to facilitate quick engine starting. Each EDG has a separate and independent lubricating system.

The lubricating oil cooler is a counter-flow shell-and-tube heat exchanger with essential service water passing through the tubes. A safety-related motor-operated three-way control valve directs bypass around the heat exchanger as needed to control inlet lubricating oil temperature to the engine. The system is designed to maintain the required operating temperatures during continuous engine operation at 110 percent rated load capacity. FSAR Tier 2, Section 9.5.7 states that the lube oil cooler has the capacity to cool the lubricating oil flow to the required inlet temperature based on engine operation at 110 percent rated load with an additional margin to allow for heat exchanger fouling and tube plugging.

When the EDG is in standby, the prelubrication pump draws oil from the engine-sump and circulates clean oil to the bearings and other moving parts through a keep-warm heater. Prelubrication minimizes wear on rotating components during engine start, supports quick-start capability, and cleans and filters the oil during standby periods. The duplex strainers in the prelubrication system each permit 100 percent oil flow, so that they can be cleaned and maintained without impact on system operation. NUREG/CR-0660 cautions against prelube periods exceeding 5 minutes unless approved by the diesel manufacturer. SRP Section 9.5.7, Sections III.3.F and G, which are based on NUREG/CR-0660, state the same caution. FSAR Tier 2, Section 9.5.7.3.1, "Normal Operation," states that during standby, this system provides continuous prelubrication. Therefore, in RAI 87, Question 09.05.07-1, the staff requested that the applicant clarify how the DGLS complies with the guidelines presented in SRP Section 9.5.7 Sections III.3.F and G.

In a November 10, 2008, response to RAI 87, Question 09.05.07-1, the applicant clarified the NUREG/CR-0660 recommendation by stating that it was intended to apply to manual prelubrication where the engine is completely charged with oil such that oil could leak into cylinders or exhaust manifolds. This prelubrication would only be done following engine maintenance outages and in such a case, the NUREG/CR-0660 or manufacturer's recommendations would be followed. The applicant also stated that the lube oil keep-warm system is designed and supplied by the engine manufacturer to circulate oil and keep it warm during engine standby periods and that it is designed so that oil will not enter cylinders or exhaust and, therefore, is designed to operate continuously. The applicant concluded that the NUREG/CR-0660 recommendations on prelubrication are not applicable to the keep-warm system.

The staff reviewed the applicant's response and concurred that a DGLS keep-warm system designed to prevent lube oil from entering cylinders or exhaust during continuous operation satisfies the SRP Section 9.5.7 recommendation that the system be designed to minimize potential fire hazards from leaking lube oil accumulating on the engine exhaust manifold and in the turbocharger housing. The staff also noted that SRP Section III.3.F states that prelube time intervals should be limited to 3 to 5 min. unless otherwise recommended by the EDG manufacturer.

In a November 10, 2008, response to RAI 87, Question 09.05.07-1, the applicant also stated that the electric-driven prelubrication pump provides continuous prelubrication and filtering of the lube oil within the operating temperature limits during engine standby and is shut down during engine operation. The staff agreed that this feature meets the SRP Section 9.5.7 recommendation that the DGLS system be designed to address the tendency for lube oil to drain during long standby periods and the potential to starve oil supplied bearings during emergency engine starts. The applicant stated that the NUREG/CR-0660 recommendations on prelubrication are not applicable to the keep-warm system. Based on the additional information provided by the applicant, the staff concluded that the recommendations of SRP Section 9.5.7, Section III.3.F and G were satisfied. Therefore, the staff considers RAI 87, Question 09.05.07-1 resolved.

Each unit has four independent EDGs, each with a separate and independent DGLS that is not shared between other diesel generators or other nuclear units. Therefore, the staff finds that the DGLS meets the requirements of GDC 5.

The safety-related portions of the DGLS are classified as Quality Group C and Seismic Category I. FSAR Tier 2, Figure 9.5.7-1, "Emergency Diesel Generator Lubricating Oil System," has designated the non-safety-related prelubrication and keep-warm portion of the DGLS as non-seismic category and Quality Group E. FSAR Tier 2, Section 3.2.1.5, "Non-Seismic," defined NSC components as not subject to any seismic design criteria invoked by the applicable commercial or industrial codes and standards, and not falling within the RG 1.29 criteria for classification as Seismic Category I or II. Therefore, the prelubrication and keep-warm portion of the DGLS may fail during a seismic event. Since the prelube and keep warm systems are directly connected to the safety-related, Seismic Category I section of the DGLS, the staff requested in RAI 87, Question 09.05.07-2, that the applicant explain how a non-seismic fluid system connected directly to a Seismic Category I fluid system will not adversely affect the

Seismic Category I system and possibly cause the safety-related portion to not lose fluid and pressure.

In a February 18, 2009, response to RAI 87, Question 09.05.07-2, the applicant stated that the seismic classification of the prelube and keep warm portion of the DGLS will be changed from non-seismic to Seismic Category II. The applicant noted that the response to RAI 87, Question 09.05.07-2, produced changes to FSAR Tier 1, Table 2.5.4-1 and FSAR Tier 2, Figure 9.5.7-1. These changes involved the safety classification from non-safety-related to supplemented grade (NS-AQ) and changing the Quality Group from Group E to Group D. The applicant stated that FSAR Tier 2, Table 3.2.2-1 and FSAR Tier 2, Section 9.5.7.2.2, "Component Description," will be revised to reflect these changes.

The staff reviewed the Revision 2 changes to the FSAR and finds them acceptable.

In keeping with the guidelines of the SRP Section 9.5.7 acceptance criteria, a negative pressure is maintained in the engine crankcase area by the crankcase vacuum system. In addition to minimizing oil leakage, the slight vacuum removes oil vapors to minimize the potential for crankcase explosions caused by overheated parts. The vacuum system contains an exhauster that discharges to the engine exhaust system after passing through an oil separator.

Portions of the DGLS important to safety are housed within the EPGB, as shown in FSAR Tier 2, Figure 9.5.7-1. Each EPGB is classified as Seismic Category I and is designed to withstand the effects of earthquakes, tornadoes, hurricanes, floods, external missiles, and other natural phenomena, as described in FSAR Tier 2, Sections 3.3 to 3.8. The safety-related portions of the DGLS are designed to remain functional after a SSE. FSAR Tier 2, Section 9.5.7.2.2 states that the auxiliary lube oil tank is located in the EPGB. FSAR Tier 2, Figure 9.5.7-1 shows a fill line with an oil filter and a vent line. The staff is not certain whether the fill and vent lines are also in the EPGB. Therefore, in RAI 87, Question 09.05.07-3, the staff requested that the applicant specify if these lines are in the EPGB and are protected in accordance with GDC 2 and GDC 4 from natural phenomena like earthquakes, tornadoes, hurricanes, floods, and missiles.

In a November 10, 2008, response to RAI 87, Question 09.05.07-3, the applicant stated that the auxiliary lube oil tank, which is provided to supply makeup during extended engine runs, is located in the diesel room and is filled and vented within the EPGB. No portion of the DGLS is located outside the EPGB. The applicant stated that the design provides protection from natural phenomena and complies with requirements of GDC 2 and GDC 4. The staff found this explanation to be satisfactory and did not require further discussion on this matter. The staff concurs that the GDC 2 and GDC 4 requirements have been met relative to protections for the auxiliary lube oil tank. Therefore, the staff considers RAI 87, Question 09.05.07-3 resolved.

The applicant stated that there are no high-energy lines in the EPGB, but did not discuss the presence of moderate-energy lines in the EPGB. Until the applicant addresses the effect of moderate-energy lines in the EPGB on the DGLS, the staff could not make a determination whether the applicant complies with GDC 4. Therefore, in RAI 87, Question 09.05.07-4, the staff requested that the applicant discuss any effect of a break in a moderate-energy line in the EPGB on the DGLS. In a November 10, 2008, response to RAI 87, Question 09.05.07-4, the applicant stated that there were no high- or medium-pressure lines in the EPGB that are not Part of the respective EDG. The applicant further stated that no high- or moderate-energy line of any single EDG could affect more than one EDG. Therefore, the failure of a high- or moderate-energy line could affect the availability of that EDG to function, but that the other divisional diesels would not be affected. This failure is addressed as a single failure that is limited to one divisional EDG. Considering the layout and physical separation of the divisional EDGs in the design of the U.S. EPR, the staff concurred that single failures associated with high- or moderate energy lines in the EPGB will not impact more than one divisional diesel. In view of the foregoing, the staff finds the November 10, 2008, response to RAI 87, Question 09.05.07-4 acceptable, and the requirements of GDC 4 for the DGLS have been met. Therefore, the staff considers RAI 87, Question 09.05.07-4 resolved since GDC 2 and GDC 4 are met.

The guidelines of SRP Section 9.5.7 specify that part of the acceptance criteria to meet GDC 17 requirements is that DGLS operating pressure, temperature differentials, flow rate, and heat removal rate external to the engine are in accordance with the engine manufacturer. Also, 10 CFR 52.47(b)(1) requires that a U.S. EPR application contain the proposed ITAAC that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a plant that incorporates the U.S. EPR is built and will operate in accordance with the design certification, the provisions of the Atomic Energy Act of 1954, and NRC regulations. The staff reviewed FSAR Tier 1, Section 2.5.4, and verified that appropriate design description and ITAAC have been included in accordance with the regulatory requirements.

SRP Section 9.5.7 specifies that in meeting the GDC 17 requirements, the onsite lubricating oil storage capacity for each diesel engine needs to be sufficient for 7 days of operation. FSAR Tier 2, Section 9.5.7.2.2 states that the safety-related auxiliary lube oil tank provides supplementary lube oil volume for oil consumption makeup during a 7-day period of operation of the EDG. The tank is connected to the engine sump and an automatic solenoid operated valve maintains the required oil level in the engine sump. The engine lube oil sump, supplemented by a makeup tank, contains sufficient lube oil to operate for 7 days under the worst expected operating conditions before additional lube oil is needed.

The engine lube oil sump tank description in FSAR Tier 2, Section 9.5.7.2.2 states that the sump design incorporates provisions to obtain a lube oil sample for quality analysis. The tank is internally coated to prevent corrosion and introduction of corrosion products into the stored oil. The auxiliary lube oil tank has a low point drain for removing any accumulated water from the tank and sample analysis. Filling of the auxiliary tank is accomplished by adding lube oil with a portable pump through an installed in-line replaceable filter to avoid contamination of the stored lube oil. These features are in accordance with the recommendations of ANSI/ANS 59.52-1988 and, therefore, provide suitable reliability features as required by GDC 17.

FSAR Tier 2, Section 9.5.7.6, “Instrumentation Requirements,” provides the instrumentation requirements. The lube oil temperatures, pressures, and levels which alarm locally and result in a common main control room alarm are given. They include:

1. High lube oil temperature from engine

2. High lube oil filter differential pressure

3. Low lube oil pressure to engine

4. Low lube oil sump temperature

5. Low lube oil sump level

Operation of any two of the three low-low lube oil pressure setpoints initiates automatic shutdown of the engine. None of the other malfunctions shut down the engine in emergency operation or result in any effects which require immediate operator action. Local indication is provided for lube oil temperature to and from the lube oil cooler and to the engine; lube oil filter differential pressure; and lube oil pressure to the engine. This meets the SRP Section 9.5.7 guidelines which state that normal protective interlocks do not preclude engine operation during emergency conditions.

FSAR Tier 2, Chapter 14.2, Test No. 104 (EDG mechanical), Test No. 105 (EDG electrical), and Test No. 106 (EDG auxiliaries) all focused on the EDGs. Test No. 106, in particular, tests the lubricating system in accordance with the provisions of FSAR Tier 2, Section 9.5.7, including the prelubrication components.

9.5.7.5 *Combined License Information Items*

No applicable items were identified in the FSAR. No additional COL information items need to be included in FSAR Tier 2, Table 1.8-2 for DGLS consideration.

9.5.7.6 *Conclusions*

Based on the foregoing evaluation, the staff finds that the application meets the requirements of GDC 2, GDC 4, GDC 5, GDC 17, and 10 CFR 52.47(b)(1).

9.5.8 Diesel Generator Air Intake and Exhaust System

9.5.8.1 *Introduction*

The review of the U.S. EPR Class 1E emergency diesel generator air intake and exhaust system (DGAIES) is to assure compliance of the system design with the requirements of GDC 2, GDC 4, GDC 5, and GDC 17 and 10 CFR 52.47(b)(1). The DGAIES provides combustion air to the emergency diesel generators. Combustion air passes through a filter silencer, and heater before being compressed by a turbo charger for injection into the engine cylinders. The outlet of the turbocharger is cooled by the EDG cooling water system. Exhaust gases are conveyed to the environment via the engine-mounted turbocharger, emissions equipment, and exhaust silencers. Each EDG has a separate and independent DGAIES.

9.5.8.2 *Summary of Application*

FSAR Tier 1: The U.S. FSAR Tier 1, Section 2.5.4 describes the principal performance characteristics and safety functions of the emergency diesel generators and their supporting equipment, including Table 2.5.4-1, Table 2.5.4-2, Table 2.5.4-3, Table 2.5.4-4, and Figure 2.5.4-3, “Emergency Diesel Generator Air Intake and Exhaust System Functional Arrangement.” FSAR Tier 1, Section 2.5.4, Item 3.15, states that each EDG exhaust path has a bypass exhaust path. Other items in this section state the design requirements for the ASME Section III and Seismic Category I portions of all of the EDG support systems.

FSAR Tier 2: The applicant has provided a system description in FSAR Tier 2, Section 9.5.8, “Diesel Generator Air Intake and Exhaust System,” summarized here in part, as follows:

FSAR Tier 2, Section 9.5.8 describes the EDG air intake and exhaust system. The diesel engines receive combustion air from outside of the EPGB through missile-protected air ducts on the upper floor. Combustion air passes through a filter, silencer, heater and inlet damper before entering the engine turbocharger. The turbocharger uses the kinetic energy of the exhaust gases to compress the combustion air. The exhaust gas system contains piping, emissions controls, and a silencer. The exhaust system is insulated to limit radiated heat into the building.

ITAAC: FSAR Tier 1, Table 2.5.4-4, provides ITAAC requirements for the EDGs. Item 2.5 of this table requires verification of the functional arrangement of the DGAIES. Table 2.5.4-4 provides specific requirements for verification of the bypass exhaust path (Item 3.15). In addition, there are other ITAAC that apply generally to all of the EDG support systems, including Items 2.2, 3.7, 3.13, 3.16 through 3.24, 4.1, 4.2, 4.3, 5.2, 5.4, and 6.5.

Technical Specifications: FSAR Tier 2, Chapter 16 does not specifically identify the EDG air intake and exhaust systems. However, EDG testing and surveillance requirements under TS 3.8.1 will indirectly measure the effectiveness of air intake and exhaust in that these systems are an integral part of EDG performance and capacity.

9.5.8.3 *Regulatory Basis*

The relevant requirements of NRC regulations for this area of review, and the associated acceptance criteria, are specified in NUREG-0800, Section 9.5.8, “Emergency Diesel Engine Combustion Air Intake and Exhaust System,” and are summarized below. Other areas of review (other SRP sections) that include interfaces with this SRP section are identified in NUREG-0800, Section 9.5.8.

1. GDC 2, as it relates to SSCs important to safety that must be protected from, or capable of withstanding, the effects of such natural phenomena as earthquakes, tornadoes, hurricanes, and floods as described in FSAR Tier 2, Chapters 2 and 3.

2. GDC 4, as it relates to SSCs important to safety that must be protected from, or capable of withstanding, the effects of externally generated missiles, internally generated missiles, pipe whip, and jet impingement forces associated with pipe breaks.

3. GDC 5, as it relates to the capability of DGAIES systems and components important to safety shared between units to perform required safety functions.

4. GDC 17, as it relates to the capability of the DGAIES to support the requirement for independence, redundancy, and testability of the onsite electric power system to assure post-accident safe shutdown.

5. 10 CFR 52.47(b)(1), which requires that a U.S. EPR application contain the proposed ITAAC that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a plant that incorporates the design certification is built and will operate in accordance with the U.S. EPR, the provisions of the Atomic Energy Act of 1954, and NRC regulations.

Acceptance criteria adequate to meet the above requirements include:

1. RG 1.26 provides guidance for the appropriate quality group classification of system components. Although this RG does not specifically apply to air and exhaust systems, the guidance can be applied to the DGAIES components.

2. RG 1.29 provides guidance for the appropriate seismic classification of system SSCs.

3. NUREG/CR-0660 provides guidance that supports compliance with GDC 17.

9.5.8.4 *Technical Evaluation*

The staff reviewed the design description of the DGAIES in the FSAR for the U.S. EPR in accordance with NUREG-0800, Section 9.5.8.

FSAR Tier 2, Section 9.5.8, describes the DGAIES. The U.S. EPR has four EDGs. Each EDG has its own dedicated and independent DGAIES. Each DGAIES consists of intake and exhaust silencers, intake filters, pipes and ducting, exhaust emission equipment, and temperature and differential pressure sensors. Each EDG receives combustion air from outside of the EPGB through an air duct inside the missile-protected area. Combustion air passes through a filter, silencer, heater and inlet damper before entering the engine turbocharger. The turbocharger uses the kinetic energy of the exhaust gases to compress the combustion air. The compressed air is cooled by an intercooler prior to entering individual cylinders. The intercooler is supplied with EDG cooling water. The cooled compressed air forces more air into each cylinder during the intake stroke of the piston, thereby increasing engine horsepower. Compressed combustion air is required for the EDG to reach its full output rating. The exhaust gas system contains piping, emissions controls, and a silencer. The exhaust system is insulated to limit radiated heat into the EPGB.

Since each EDG is supplied with a dedicated and independent DGAIES and each DGAIES is not shared between nuclear power units, the requirements of GDC 5 are met.

In conformance with RG 1.26 and RG 1.29, FSAR Tier 2, Table 3.2.2-1, lists the components of the DGAIES as safety-related, Quality Group C, and Seismic Category I, except the exhaust silencer and exhaust stack. The exhaust silencer and exhaust stack are non-safety-augmented quality, Quality Group D, Seismic Category II.

The safety-related to non-safety-related interface for the diesel generator air intake and exhaust system occurs at the penetration of the exterior wall of the EPGB, as shown in FSAR Tier 2, Figure 9.5.8-1, “Emergency Diesel Generator Air Intake and Exhaust System.” Non-safety-related SSCs located inside the EPGB are classified as Quality Class D Seismic Category II and are designed so that they will not degrade the operability of Seismic I SSCs during a design basis accident event.

All safety-related SSCs of the DGAIES are located inside the EPGB. Safety-related exhaust ducts exit the diesel hall ceiling through a penetration to an EPGB room which provides a missile protected flow path for the exhaust gas to the atmosphere. The non-safety-related DGAIES exhaust path exits the diesel hall at a different penetration, passes through the emissions control equipment, and then passes through a different portion of the EPGB on its way to the non-safety-related exhaust vent. While the non-safety-related exhaust path may be damaged by a GDC 2 event, such damage would not prevent the safety-related DGAIES exhaust path from functioning and would allow continued operation of the emergency diesel generators. The safety-related DGAIES intake air also enters the EPGB thru a separate missile protected room on the opposite side of the building. Therefore, the staff finds that the DGAIES meets the requirements of GDC 2.

The DGAIES contains exhaust emissions control equipment to meet Federal, State and local emissions requirements for emergency diesel generators with a displacement of over 30 l (7.9 gal) per cylinder. The emissions equipment is positioned downstream of the safety-related exhaust bypass stack and is located outside the EPGB. The emissions equipment is non-safety-related and non-seismic and is assigned to Quality Group E. The emissions equipment will not function when the safety-related exhaust bypass stack is open. The silencer downstream of the emissions control equipment is located inside the EPGB, is classified as Seismic Category II, and is assigned to supplemented grade (NS-AQ) quality, and Quality Group D.

The portions of the DGAIES that are part of the engine assembly are Seismic Category I but are beyond the ASME Section III boundary; therefore, the quality group classification for these components is Quality Group E.

Each EDG division is located in a dedicated room in the EPGB, which contains support systems for that division. The four divisions are separate and independent from one another. All pressure lines located in a division support only that division. A failure of any pressure line will only have the potential to impact the function of the SSCs in that division. There are no high- or moderate-energy lines in the EPGB whose failure could alter the function of more than one DGAIES. Therefore, the staff finds that the DGAIES meets the requirements of GDC 4.

SRP Section 9.5.8 lists the guidelines for the applicant to meet the requirements of GDC 17, which includes incorporating the recommendations of NUREG/CR 0660. The applicant meets these guidelines as follows.

Each EDG has a dedicated DGAIES and can provide combustion air under all operating modes. FSAR Tier 2, Section 9.5.8.3.2, “Abnormal Operation,” states that the intake filters are monitored for differential pressure and an alarm sounds in the main control room when a condition exists that could affect the operability of the engine. The filter elements are replaceable and in extreme conditions could be replaced on line. This meets the guidelines of SRP Section 9.5.8, which states that the combustion air intake system must have a means of reducing airborne particulate over the entire time period requiring emergency power assuming the maximum airborne particulate concentration.

Combustion air is taken from outside the EPGB via an air duct at elevation 15.7 m (51 ft, 6 in.). This meets the guideline presented in NUREG/CR 0660 which states that the air intake should be sufficiently (6.1 m or 20 ft) above ground level. Piping for ventilation of the EPGB is separate from that for engine combustion air, which meets the guidelines of NUREG/CR 0660. The design of the DGAIES and EPGB establishes that the arrangement and location of the combustion air intake and exhaust gas discharge are such that dilution and contamination of the intake air will not prevent operation of the EDG at rated power output or cause engine shutdown as a consequence of any metrological or accident condition. This meets the guideline of NUREG/CR 0660.

The DGAIES includes an exhaust bypass that includes a pressure actuated device that will rupture on high backpressure in the exhaust system. The rupture disk is designed to rupture within the pressure limits defined by the EDG manufacturer to maintain full engine performance in the event that the normal exhaust path becomes restricted due to damage to the non-safety-related portion of the system. The rupture disk is a safety-related, Seismic Category I component in accordance with ASME Section III, Class 3. The exhaust system instrumentation provides an alarm function which will alert the operators of a degrading condition in the normal exhaust flow path.

In RAI 263, Question 09.05.08-11, the staff requested that the applicant describe the operation of the bypass function and the type of device that would be used to provide this function. The staff also requested an explanation regarding whether a seismic event could cause sufficient damage to restrict exhaust flow and affect EDG performance, but not enough to cause the bypass to open. In a November 20, 2009, response to RAI 263, Question 09.05.08-11, the applicant stated that the rupture disk is designed per the manufacturer's specifications to open at the backpressure above which the EDG performance would be reduced. The rupture disk is Seismic Category I and ASME Code Section III Class 3 and is included in the operations and maintenance inservice testing program. The RAI also noted that the FSAR description of the bypass function did not clearly describe the rupture disk, since this device was also referred to as a bypass valve in the FSAR description. The RAI requested clarification of the bypass operation, and the applicant's response verified that the bypass is provided by a passive rupture disk and not an active bypass valve. The applicant proposed revisions to the FSAR that were in conformance with this RAI response, and that were acceptable to the staff and have been included in the FSAR.

The applicant has met the other guidelines of SRP Section 9.5.8. The applicant has stated that the layout of the piping and main components provides the space required to permit inspection, cleaning, maintenance, and repair of the system. Since each DGAIES is separate and independent, failure of any SSCs in a DGAIES will not cause the loss of more than one EDG. Safety functions can be performed assuming a concurrent single active failure and a loss of offsite power.

FSAR Tier 2, Chapter 16, does not list any specific limiting condition for operation or surveillance requirements associated with the DGAIES.

FSAR Tier 2, Section 9.5.8.5, "Inspection and Testing Requirements," states that the DGAIES is initially tested using the program detailed in FSAR Tier 2, Section 14.2, Test No. 104, Test No. 105, and Test No. 106. The operability of the system is checked by periodic testing and inspection of the complete EDG system. This testing demonstrates the performance, structural, and leak-tight integrity of each system component.

The DGAIES design features, including redundancy and independence, and the provisions for testing the system capability support the requirement for an onsite electric power system to assure post-accident safe shutdown and, therefore, meet the requirements of GDC 17.

9.5.8.5 *Combined License Information Items*

No applicable items were identified in the FSAR. No additional COL information items need to be included in FSAR Tier 2, Table 1.8-2 for DGAIES consideration.

9.5.8.6 *Conclusions*

The staff concludes that the DGAIES design is acceptable and complies with regulations as stated in the general design criteria of Appendix A to 10 CFR Part 50 and meets the requirements of GDC 2, GDC 4, GDC 5, GDC 17, and 10 CFR 52.47(b)(1).