The CSS is located in the Reactor Building and the Containment. Both structures are seismic category I and provide ~~tornado~~tornado/hurricane missile barriers to protect the CSS. The CSS includes four 50% capacity CS/RHR pump trains and assumes one is out of service for maintenance and one becomes inoperative due to a single failure upon the initiation of the CSS. The CSS is designed with sufficient redundancy to ensure reliable performance, including the failure of any component coincident with occurrence of a design basis event, as discussed in DCD Chapters 3, 7, and 15. DCD_02-03 S01

Subsection 6.2.1 discusses the containment environmental conditions during accident conditions, and Chapter 3, Section 3.11 discusses the suitability of equipment for design environmental conditions. All valves required to be actuated during CSS operation are located to prevent vulnerability to flooding.

Protection of the CSS from missiles is discussed in Section 3.5. Protection of the CSS against dynamic effects associated with rupture of piping is described in Section 3.6. Protection from flooding is discussed in Section 3.4.

MUAP-08013-P (Ref. 6.2-36) contains requirements for design and evaluation of ECCS and CSS ex-vessel downstream components to ensure the ECCS and CSS systems and their components will operate as designed under post-LOCA conditions. DCD_06.02.02-84

The CSS is designed for periodic inservice testing and inspection of components in accordance with ASME Code Section XI.

6.2.2.2 System Design

Figure 6.2.2-1 is the flow diagram of the CSS, showing the major components, instruments, and the appropriate system interconnections. Table 6.2.2-1 presents design and performance data for CSS components. The performance data for CS/RHR pump and CS/RHR heat exchanger is shown in Chapter 5, Subsection 5.4.7.

The CSS receives electrical power for its operation and control from onsite emergency power sources and offsite sources, as shown in Chapter 8. In the unlikely event of a LOCA or secondary system line break that significantly increases the containment pressure, the containment spray automatically initiates to limit peak containment pressure to well below the containment design pressure. In addition to preserving containment structural integrity, containment spray limits the potential post-accident radioactive leakage by reducing the pressure differential between the containment atmosphere and the environment and also ensures atmosphere mixing in containment. DCD_06.02.05-44

The CS/RHR system can be manually initiated and operated from the MCR and the remote shutdown console (RSC). In addition to the typical system status and operating information (e.g., valve position indication, pump run status), the containment temperature and pressure are indicated and recorded in the MCR and RSC.

Dual-use components are the CS/RHR heat exchangers and CS/RHR pumps. Motor-operated valves permit CSS or RHRS recirculation of the reactor core. The four CSS containment isolation valves are normally closed, but open automatically on a P signal. The CSS containment isolation valves are interlocked and are allowed to open only if either of the corresponding two in-series RHR hot leg suction isolation valve is

6.2.4 Containment Isolation System

The containment prevents or limits the release of fission products to the environment. The containment isolation system allows the free flow of normal or emergency-related fluids through the containment boundary in support of reactor operations, but establishes and preserves the containment boundary integrity. The containment isolation system includes the system and components (piping, valves, and actuation logic) that establish and preserve the containment boundary integrity.

The criteria for isolation requirements and the associated system design are set forth in GDC 55 through 57 of Appendix A to 10 CFR 50. Unless acceptable on some other specific and defined basis (e.g., instrument lines), two isolation barriers are required; one inside and one outside of the containment. Isolation barriers are valves, unless the piping system inside the containment is neither part of the RCPB, nor communicates directly with the containment atmosphere, and is both suitably protected and robust. This section of the DCD describes the design and functional capabilities of the US-APWR containment isolation system in compliance with these GDC.

The containment penetration barriers consisting of the flange closure, personnel airlock and equipment hatch are under administrative control.

6.2.4.1 Design Bases

As described in Chapter 3, Subsection 3.1.5, the containment isolation system conforms to GDC 54, 55, 56, and 57, and is designed to seismic category I, quality group B.The containment isolation valves are identified as Equipment Class 1 or 2, as described in Chapter 3, Section 3.2. In addition to being protected from the effects of a postulated pipe rupture and containment missiles, closed systems inside the containment considered an isolation barrier under GDC 57 are designed to withstand the containment design temperature, pressure from the containment structural acceptance test, LOCA conditions, and to accommodate the internal fluid pressure associated with the containment temperature resulting from a design basis LOCA. Instrument lines closed both inside and outside containment are designed in accordance with the guidance provided by RG 1.11, RG 1.141 and satisfy NUREG-0800, SRP 6.2.4 (Ref. 6.2-27), acceptance criterion 1. The containment isolation system is designed in accordance with the Three Mile Island (TMI)-related requirements of 10 CFR 50.34(f)(2)(xiv)(A) through (E). The discharge side of the relief valves in the CS/RHR pump suction lines is designed to withstand and be tested at the containment design pressure.

Chapter 3, Sections 3.3 and 3.4 describe how the containment isolation system is designed to accommodate the wind~~ and tornado~~, tornado and hurricane loadings, and to withstand flood levels. The design requirements for protection from internally generated missiles (for isolation system components inside and outside of the containment) are described in Chapter 3, Section 3.5. The design for protection against the dynamic effects associated with the postulated rupture of piping is described in Chapter 3, Section 3.6, while the environmental qualification program for mechanical and electrical components of the containment isolation system is described in Section 3.11. The environmental qualification program for the containment isolation components considers the effects of short-term conditions inside containment, LOCA high radiation (in addition DCD_02-03 S01

Compliance with these GDCs is discussed in Chapter 3, Section 3.1. As for 10 CFR 50.46, it is described in Subsection 6.3.1.1.

The ECCS design meets relevant items of TMI Action Plan requirements specified in 10 CFR 50.34(f), as described in Table 6.3-1.

The ECCS design incorporates the resolutions of the relevant Unresolved Safety Issues, and medium- and high-priority Generic Safety Issues that are specified in the current version of NUREG-0933, as described in Table 6.3-2 and Table 6.3-3.

The ECCS design incorporates operating experience insights from Generic Letters and Bulletins, as described in Table 6.3-4.

6.3.1.5 Reliability Design Bases

The reliability of the ECCS has been considered in selection of the functional requirements, selection of the particular components and location of components, and connected piping. Redundant components are provided where the loss of one component would impair reliability. Redundant sources of the safety injection signal (S signal) are available so that the proper and timely operation of the ECCS is ensured. Sufficient instrumentation is available so that failure of an instrument does not impair readiness of the system. The active components of the ECCS are normally powered from separate buses which are energized from offsite power supplies. In addition, redundant sources of emergency onsite power are available through the use of the emergency power sources to ensure adequate power for all ECCS requirements. Each emergency power source is capable of providing sufficient power to all pumps, valves, and necessary instruments associated with one train of the ECCS.

The ECCS is located in the Reactor Building and the Containment. Both structures are seismic category I and provide ~~tornado~~tornado/hurricane missile barriers to protect the ECCS. The SIS receives normal power and is backed up with onsite Class 1E emergency electric power as noted in Chapter 8. The ECCS includes four 50% capacity SI pump trains. This design provides sufficient flow even if one train is out of service for maintenance and another one becomes inoperable due to a single failure upon the initiation of the ECCS. The SIS is designed with redundancy sufficient to ensure reliable performance, including the failure of any component coincident with occurrence of a design basis event, as discussed in Chapters 3, 7, and 15. One accumulator is provided for each loop. Accumulator sizing is based on three accumulators to account for loss of coolant from the accumulator installed on the broken loop during a LOCA. The spilled coolant from the accumulator on the broken loop does not contribute to the core injection. DCD_02-03 S01

Subsection 6.2.1, discusses the containment environmental conditions during accidents, and Chapter 3, Section 3.11, discusses the suitability of equipment for design environmental conditions. All valves required to be actuated during ECCS operation are located so as to prevent vulnerability to flooding.

Protection of the ECCS from missiles is discussed in Chapter 3, Section 3.5. Protection of the ECCS against dynamic effects associated with the rupture of piping is described in Section 3.6. Protection from flooding is discussed in Section 3.4.

respect to the surrounding areas to minimize un-filtered inleakage during emergency operation in pressurization mode.

The design of the MCR emergency filtration units is based on ensuring that the radiation dose (total effective dose equivalent [TEDE]) to MCR operators is well below 10 CFR 50, Appendix A "General Design Criteria 19" guidelines (Ref. 6.4-1) (5 roentgen equivalent in man [rem] TEDE) while occupying the CRE for the duration of the most severe Chapter 15 accident. The MCR emergency filtration design basis also ensures that control room personnel and equipment are protected in an environment satisfactory for extended performance.

As noted in Chapter 3, the MCR HVAC system is designed to Equipment Class 3, seismic category I standards. The CRE is an area of the control room complex in the power block. Accordingly, the CRE is, by definition, the same equipment class and seismic category (e.g., Equipment Class 3, seismic category I) as the MCR.

6.4.2 System Design

The MCR HVAC system has two emergency modes: pressurization mode and isolation mode.

The pressurization mode protects the MCR operators and staff within the CRE during the accident conditions postulated in Chapter 15. The pressurization mode is initiated automatically by the MCR isolation signal (refer to Chapter 7), i.e., any one of the following:

- ECCS actuation signal
- High MCR outside air intake radiation

The isolation mode protects the MCR operators and staff within the CRE from external toxic gas or smoke.

In the normal operation mode, the MCR HVAC system draws in outside air through either of the two ~~tornado-generated~~tornado/hurricane-generated missile protection grids and the tornado depressurization protection dampers. Incoming air is directed to any two of the four 50% capacity MCR air handling units. One of the two 100% capacity MCR toilet/ kitchen exhaust fans exhaust a portion of the air supplied to the MCR to the outside, while the majority of MCR ventilation air flow recirculates. Figure 6.4-2 shows the air flow path in the normal operating mode. Normal operation of the MCR HVAC system is discussed in Chapter 9, Subsection 9.4.1. DCD_02-03 S01

The emergency pressurization mode establishes a CRE pressure higher than that of adjacent areas. For automatic initiation in emergency pressurization mode, a portion of the return air flow is directed into the emergency filtration units. Outside air is drawn in through either of the two ~~tornado-generated~~tornado/hurricane-generated missile protection grids and the tornado depressurization protection dampers, and is directed to both 100% capacity MCR emergency filtration units and all 50% capacity MCR air handling units. The equipment drain lines for the air handling units are safety related, seismic category I and include a loop seal to prevent an unfiltered path for radioactive DCD_02-03 S01 DCD_06.04-16

Table 6.4-2 Main Control Room Emergency Filtration System – Comparison to Regulatory Guide 1.52 (Sheet 2 of 4)

No.	Regulatory Position Summary	US-APWR Design
3.7	Flow rate and differential pressure indicated, alarmed and recorded in MCR	Main Control Room Emergency Filtration Unit fan low flow alarmed (both trains) in MCR, differential pressure across each filter (prefilter, HEPA, and afterfilter) indicated locally, and CRE pressure stored in the process computer during emergency CRE ventilation
3.8	RGs 1.30, 1.100, and 1.118, and IEEE 334 should be considered in design. Electrical supply and distribution design should be designed to RG 1.32. I&C should be designed to IEEE Std 603-1991, and EQ qualified and tested by RG 1.89	Applicable to US-APWR design.
3.9	Automatic actuation by redundant LOCA signals	System is automatically initiated by main control room isolation signals or when toxic material is detected. Signals are fully redundant.
3.10	Trains totally enclosed to control leakage and designed to facilitate inspection, maintenance (while precluding contamination), and testing to RG 8.8	Filtration units are totally enclosed and designed in accordance with RG 8.8 (Ref. 6.4-7)
3.11	Outdoor air intakes protected to minimize the effects of onsite, offsite, and environmental contaminates	Outside air intakes include ~~tornado-generated~~tornado/hurricane-generated missile protection grid and a tornado depressurization protection dampers. In addition, outside air is filtered and monitored in order to ensure that potential environmental contaminants do not adversely affect the operation of the MCR HVAC system. DCD_02-03 S01
3.12	Exhaust ductwork maximum leakage defined and test performed by Section SA-4500 of ASME AG-1-1997	Exhaust ductwork maximum leakage is defined by Section SA-4500 of ASME AG-1-2003.
3.12a	Exhaust ductwork maximum leakage test performed by Section TA of ASME AG-1-1997	Exhaust ductwork maximum leakage test performed by Section TA of ASME AG 1-2003
4.	Component Design Criteria and Qualification Testing	
4.0	Components designed, constructed and tested to Division II of ASME AG-1-1997, as modified and supplemented below:	Applicable to US-APWR design, including ASME AG 1-2003.
4.1-4.5	Components designed in accordance with ASME AG-1-1997	Applicable to US-APWR design, including ASME AG 1-2003.
4.1-4.5	Components constructed and tested to ASME AG-1-1997	Applicable to US-APWR design, including ASME AG 1-2003.
4.6	Filter and adsorber banks arranged in accordance with ERDA 76-21 and AG-1a-2000	Applicable to US-APWR design, including ASME AG 1-2003.

8.2.1.2.1 Switchyard

The plant switchyard design is site-specific. The COL Applicant is to provide at least two physically independent power circuits between the offsite grid systems and the plant's high voltage switchyard. The design of the interface is to be provided by the COL Applicant. There are two physically independent transmission tie lines from the plant high voltage switchyard to the onsite transformer yard. These two power circuits are designed and located to minimize, to the extent practical, the likelihood of their simultaneous failure under operating condition and postulated accident conditions. Each power circuit has sufficient capacity and capability to assure satisfactory operation of all safety-related loads and non safety-related loads.

All relay systems used for protection of offsite power circuits and transformers are provided with primary and back-up protection. The COL Applicant is to provide protection relaying of offsite power circuits.

8.2.2 Analysis

The preferred offsite power system is designed consistent with the following criteria, so far as they are applicable to non-Class 1E equipment and system. Any exceptions or clarifications to the applicable criteria are explained.

8.2.2.1 Applicable Criteria

- GDC 2, "Design Bases for Protection Against Natural Phenomena"

  Equipment and components of the offsite power system are non-Class 1E and are located outdoors except for the connections to Class 1E MV buses, which are located indoors. The effects of natural phenomena are considered in designing the offsite power system to withstand without loss of capability to perform their intended functions within the conditions as provided in Chapter 2 such as high and low atmospheric temperatures, high wind, rain, ice and snow, but it not specifically designed to withstand earthquakes, tornadoes, hurricanes or floods. Lightning protection of the offsite power system is described in conformance with RG 1.204 (Reference 8.3.1-16). The normal and alternate preferred offsite power circuits are physically separated and electrically isolated, so that failure of an active component in one circuit has no impact to the on the other circuit. DCD_02-03 S01

- GDC 4, "Environmental and Dynamic Effects Design Bases"

  All equipment and components of the offsite power system are designed to withstand the effects of, and are operable under the environmental conditions associated with normal conditions, maintenance, testing and postulated accidents; and are appropriately protected against dynamic effects that may result from equipment failures, including missiles, pipe whipping and discharging fluids. Each transformer of the offsite power system is provided with its own oil containment system, and accidental oil leakage from one transformer has no impact on the remaining transformers. There are no high or moderate energy lines or missile generating rotating equipment in the connections between the Class 1E 6.9kV buses and non-Class 1E selector circuits are administratively controlled and are closed manually during SBO condition. Class 1E 6.9kV buses A or B can be connected to the A-AAC GTG, and Class 1E 6.9kV buses C or D can be connected to the B-AAC GTG, during SBO condition. The major Class 1E distribution equipment of train A, B, C and D are physically separated by different rooms as shown in Figure 8.3.1-4. Redundant safe shutdown components and associated redundant Class 1E electrical trains are separated from the other Class 1E and non-Class 1E systems by 3-hour rated fire barriers to preserve the capability to safely shutdown the plant following a fire (Subsection 9.5.1.1). Access to the Class 1E power equipment areas is administratively controlled. The R/B and safety-related PS/Bs are structurally designed to meet seismic category I requirements as defined in RG 1.29 (Reference 8.3.1-3). These structures are designed to withstand the effects of natural phenomena such as hurricanes, floods, tornados, tsunamis, and earthquakes without loss of capability to perform safety functions. They are also designed to withstand the effects of postulated internal events such as fires and flooding without loss of capability to perform safety functions (Subsection 1.2.1.2.11). The orientation of the R/B and safety-related PS/Bs where Class 1E onsite power system components are located, is such that the probability of a turbine missile striking the R/B or PS/Bs is minimum. The Class 1E onsite power system components are also protected from internally generated missiles ~~and tornado generated missiles~~, tornado generated missiles and hurricane generated missiles. Safety-related components are protected against dynamic effects, including the effects of missiles, pipe whipping, and discharging fluids as a result from equipment failure or events and conditions outside the nuclear power unit. Class 1E equipment important to safety will be protected from the dynamic effects of pipe rupture and are capable of performing their intended safety functions (Subsection 3.6.1). DCD_02-03 S01

Auxiliary support systems such as fuel oil systems, compressed air systems and control power supplies are also separate and independent for each Class 1E train. The Class 1E power to the auxiliary support systems is derived from the same train they serve. The heating, ventilation, and air conditioning (HVAC) systems that support operation of the Class 1E ac distribution equipment are powered from the redundant Class 1E ac power system as described in Subsection 9.4.5.

The four Class 1E trains are electrically isolated from the offsite power supplies and each other. The power sources to Class 1E 6.9kV buses are not operated in parallel except for a short period of time during the testing of Class 1E GTGs in parallel with an offsite source. There are no automatic tie connections between the redundant Class 1E trains. The manual tie connection between train B load center and train A load center A1, and between train C load center and train D load center D1 are closed manually, only during the maintenance of the Class 1E A-GTG or Class 1E D-GTG. The tie circuit breakers are mechanically interlocked to prevent parallel connection of load center A1 to load centers A and B, and load center D1 to load centers C and D.

Non-Class 1E loads, except for the emergency lighting and pressurizer heater circuits, are not supplied from the Class 1E power systems. The circuits for non-Class 1E loads are electrically isolated from the Class 1E power system by Class 1E isolation devices. Pressurizer heater Back-up groups are supplied from the Class 1E power systems based on 10 CFR 50.34(f)(2)(xiii).

9.0 AUXILIARY SYSTEMS

9.1 Fuel Storage and Handling

9.1.1 Criticality Safety of New and Spent Fuel Storage

9.1.1.1 Design Bases

New and spent fuel storage facilities are located in the fuel handling area of the reactor building (R/B) which is designed to meet the seismic category I requirements of Regulatory Guide (RG) 1.29. New fuel is stored in low density racks installed in a dry new fuel storage pit. Spent fuel is stored in moderate density racks installed in a spent fuel pit (SFP) filled with borated water. Additionally, containment racks installed in the refueling cavity provide temporary storage for new or irradiated fuel assemblies during refueling operations. DCD_12.03-12.04-40 DCD_12.03-12.04-42

New fuel storage racks store 180 fuel assemblies, which corresponds to approximately one normal refueling batch plus an additional 50 locations. One normal refuel batch for the United States - Advanced Pressure Water Reactor (US-APWR) is one-half of a core. The center-to-center spacing between adjacent fuel assemblies is designed to be 16.9 in (as shown in Figure 9.1.1-1) to maintain subcriticality.

Spent fuel storage racks are capable to receive 900 fuel assemblies corresponding to the amount of spent fuel from ten years of operation at full power in case of a 24-month fuel cycle, plus one full-core discharge. The center-to-center spacing between adjacent fuel assemblies is designed to be 11.1 in (as shown in Figure 9.1.1-2) to maintain subcriticality.

Containment racks provide temporary storage for new or irradiated fuel assemblies to facilitate refueling operations. Two containment racks are located in the refueling cavity (as shown in Figure 9.1.2-3) that provide temporary storage for a total of 6 fuel assemblies with center-to-center spacing of 16.9 in. (as shown in Figure 9.1.2-4) to maintain subcriticality. DCD_12.03-12.04-40 DCD_12.03-12.04-42

The fuel storage and handling area is protected against natural phenomena. The robust concrete walls and ceiling surrounding the fuel storage and handling area is designed to withstand the loads and forces caused by earthquake, wind, tornados, hurricanes, floods and internal and external missiles. DCD_02-03 S01

New ~~and~~fuel storage racks, spent fuel storage racks, and containment racks are designed to maintain the required degree of subcriticality, and are evaluated as seismic category I structures. Equipment potentially damaging the stored fuel is designed to be prevented from collapsing and falling down on the structures in the event of a safe-shutdown earthquake (SSE). DCD_12.03-12.04-40 DCD_12.03-12.04-42

Criticality is precluded by adequate design of fuel handling and storage facilities and by administrative control procedures. The basic method of preventing criticality is the control of geometrically safe configurations. This is accomplished by providing geometrically safe spacing between assemblies to reduce neutron interaction. Credit for neutron absorber material is taken for the spent fuel storage rack and the spent fuel rack cells which

The structure of the new fuel storage pit supports the weight of the new fuel rack at the floor level. The new fuel storage rack, as shown in Figure 9.1.2-1, consists of individual vertical cells interconnected to each other at several elevations. The rack module is not anchored to the pit floor. The new fuel storage pit is covered by solid lids and an access platform. For each cell, the lids are normally closed and prevent misloading of a new fuel assembly in the space between the cells. The access platform provides passage between racks for inspection of the new fuel. Both the lids and access platform are designed not to fall or collapse in the event of the SSE.

The new fuel storage pit is provided with a drain system, which is connected to the R/B sump to prevent the new fuel pit from being flooded by an unanticipated release of water. The design of the drain piping system includes a check valve to prevent backflow into the new fuel pit storage area through the drain system. The new fuel rack storage cells are each designed with an opening at the bottom of each of the four sides, which can drain such unanticipated release of water. These openings are sized the same as the openings at the botoom of the spent fuel storage rack cells.

Center-to-center spacing of the new fuel rack array is 16.9 inches as shown in Figure 9.1.2-1, which provides a minimum separation between adjacent fuel assemblies. This design is sufficient to maintain a subcritical array even in the event of the new fuel storage pit being flooded with unborated water, fire extinguishing aerosols or during any design basis event. Additionally the design of the rack is such that a fuel assembly cannot be inserted into a location other than a location designed to receive an assembly, and an assembly cannot be inserted into a full location. Surfaces that come into contact with the fuel assemblies are made of annealed austenitic stainless steel, and are smooth (125AA) in accordance with the requirement of ANSI/ANS-57.2.

9.1.2.2.2 Spent ~~f~~Fuel ~~s~~Storage

DCD_02-03 S01

The SFP, including its integrally attached liner, is designed as seismic category I and is located within the seismic category I reactor building fuel handling area. The spent fuel storage pit and its liner are designed for loads and load combinations addressed in DCD Subsection 3.8.4.3 and Table 3.8.4-3. Applicable loads include but are not limited to dead, live, hydrostatic, hydrodynamic, seismic, normal operating, accident thermal, and spent fuel assembly drop loads. The spent fuel storage pit and its liner are designed to maintain their structural integrity and remain leak tight under all applicable design loads and load combinations. The walls of the SFP are an integral part of the seismic category I reactor building structure. The facility is protected from the effects of natural phenomena such as earthquakes (Section 3.7), wind, ~~and~~hurricanes, tornados (Section 3.3), floods (Section 3.4), and external missiles (Section 3.5). The facility is designed to maintain its structural integrity following a SSE and to perform its intended function following a postulated event such as a fire. Refer to Subsection 1.2.4.1 for further discussions of the reactor building fuel handling area. DCD_02-03 S01

The SFP is approximately 47 feet deep, made of reinforced concrete lined with stainless steel plate. The SFP normal water level is approximately 1 ft -2 in. below the operating floor with approximately 400,000 gallons of borated water. This water level allows a spent fuel assembly to be transferred with at least 133 inches of water shielding above the top of the fuel assembly for personell protection. The SFP is lined with stainless steel. The liner surface will have a 2B or higher finish, selected to minimize accumulation of

- Supplies boric acid water to the chemical and volume control system (CVCS) charging pump as an alternate water source.

9.1.3.1 Design Bases

The SFPCS is designed to meet the overall US-APWR plant design criteria. Specific design bases for the SFPCS are as follows:

- The cooling portion of the SFPCS is classified as Equipment class 3, and is safety-related and is designed in accordance with the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code III, Class 3, seismic category I standard (Ref.9.1.7-10).

- The system, using two SFPCS trains, is designed to maintain a SFP temperature below 120°F during a partial core offload with a fully loaded SFP and heat load from previously discharged spent fuel and the newly offloaded partial core. In case of a SFPCS single active failure, the system is designed to maintain a SFP temperature below 140°F.

- The system, using two SFPCS trains in conjunction with two trains of residual heat removal (RHR), is designed to maintain a SFP temperature below 120°F during a full core offload with a fully loaded SFP and heat load from previously discharged spent fuel and the newly offloaded full core. In case of any single active failure, the system is designed to maintain a SFP temperature below 140°F.

- The system is designed to perform purification of the SFP water, the refueling cavity, the RWSAT, and the RWSP without causing any interruption in the refueling operation. The SFP water cleanliness requirement for normal operation is shown in Table 9.1.3-1. Standard and limit values are consistent with EPRI Primary Water Chemistry Guidelines (Ref. 9.1.7-11).

- The SFPCS provides heat removal for the pit water by circulating the pit water with the SFP pump, and removing decay heat with the SFP heat exchanger through the component cooling water system (CCWS).

- Protection of the cooling portion of the SFPCS against natural phenomena and internal and external missiles is addressed in the following sections in Chapter 3:

  - Section 3.3 – Wind, Hurricane, and Tornado Loadings DCD_02-03 S01

  - Section 3.4 – Water Level (Flood) Protection

  - Section 3.5 – Missile Protection

  - Section 3.7 – Seismic Design

  - Section 3.11 – Environmental Qualification of Mechanical and Electrical Equipment

- The system, in conjunction with the plant UHS, is designed to remove heat from the plant auxiliaries required to mitigate the consequences of a design basis event and for safe shutdown, assuming a single failure and one train unavailable due to maintenance coincident with a loss of offsite power pursuant to the requirements of GDC 44.
- ESWS is designed to equipment Class 3 and seismic category requirements, and as such it is designed to remain functional during and following an SSE per RG 1.29.
- The system is designed considering the protection against adverse environmental, operating, and accident conditions that can occur, such as freezing, thermal overpressurization, and water hammer per RG 1.206.
- The system is designed in accordance with Regulatory Guide 4.21, "Minimization of Contamination and Radioactive Waste Generation: Life-Cycle Planning" (Ref. 9.2.11-9) to detect and preclude uncontrolled release of radioactive contaminants to the environment. Radioactive contaminants may enter the ESWS from the component cooling water system (CCWS). A discussion of the design objectives and operational programs to address these radiological aspects of the system is contained in DCD Section 12.3.1. System and component design features addressing RG 4.21 (Ref. 9.2.11-9) are summarized in Table 12.3-8.
- Measures to prevent long-term corrosion and organic fouling in the ESWS are considered pursuant to the requirements in SRP 9.2.1 and RG 1.206.
- Protection against natural phenomena for the safety-related portions are provided such as protection from wind, hurricane, and tornado effects, as described in Section 3.3; flood protection as described in Section 3.4; internal missile protection as described in Section 3.5; protection against dynamic effects associated with the postulated rupture of piping as described in Section 3.6. Environmental qualification of Class 1E equipment is described in Section 3.11; seismic design is described in Section 3.7, and fire protection is described in Section 9.5. DCD_02-03 S01
- The ESWS is constructed in accordance with ASME Section III, Class 3 requirements.
- The ESWS is designed to permit periodic inservice testing and inspection of components to assure system integrity and capability in accordance with GDC 45 and ASME Code Section XI.
- The ESWS is designed to permit appropriate pressure and functional testing to assure the structural and leaktight integrity of components, operability and the performance of the active components of the system, and system operability during reactor shutdown, loss-of-coolant accidents, including operation of applicable portions of the protection system and the transfer between normal and emergency power sources per GDC 46.

of service to treat this problem. Therefore, prior to occurrence of radioactive leakage into the ESWS, isolation of the affected CCWS train should have taken place first.

Clogging of the CCW heat exchanger is prevented by the ESWP discharge strainer. If the heat exchanger differential pressure on the essential water side is higher than setpoint, the alarm will be annunciated to the MCR. The operator can perform backwashing of the CCW heat exchanger locally. Because of the reverse flow through the CCW heat exchanger, there is a possibility that the CCW heat exchanger will not perform the design heat transfer from the CCWS to ESWS and the train is therefore considered inoperable. If the backwash operation will reduce the number of operable trains to fewer than three, the backwashing of the heat exchanger shall be finished and the train shall be restored within completion time of 72 hours in accordance with Technical Specification 3.7.8 DCD_09.02.01-32

9.2.1.2.3.2 Emergency Operation

Loss of Coolant Accident (LOCA)

All ESWPs are automatically started by the ECCS actuation signal, and supply cooling water to their respective CCW HXs and essential chiller units. When offsite power is not available, ESWPs are automatically powered by onsite Class 1E power supplies.

During LOCA conditions, a minimum of two trains of the ESWS are required.

Loss of Offsite Power

On loss of offsite power, onsite Class 1E gas turbine generators (GTGs) are automatically started to restore power to the Class 1E 6.9 KV power buses that service safety-related active components such as ESWS pumps and discharge MOVs. GTG operation, including automatic starting and sequencing logic, is further described in Subsection 8.3.1. During this condition, a minimum of two trains of ESWS are required.

9.2.1.3 Safety Evaluation

The safety-related portion of the ESWS is designed and constructed to seismic category I requirements. The safety-related portions of the ESWS are protected against natural phenomena and missiles. The following sections address natural phenomena and missiles protection.

- Section 3.3, Wind, hurricane, and tornado loadings DCD_02-03 S01
- Section 3.4, Water Level (Flood) Protection
- Section 3.5, Missile Protection
- Section 3.7, Seismic Design;

Pipe rupture protection is addressed in Section 3.6, Protection against Dynamic Effects Associated with Postulated Rupture of Piping.

- After any system drainage, venting is assured by personnel training and procedures.
- System valves are slow acting.

The CCWS is under pressure due to the static water head of the surge tank. In case of an earthquake, piping in non-earthquake resistant buildings may break. However, voiding, and associated water hammer potential, will not develop even if pressure is reduced in the broken section to atmospheric because the CCW water temperature is less than the saturation temperature at atmospheric pressure. Moreover, as isolation valves to the non-earthquake resistant buildings close because of low-low surge tank water level, the surge tank maintains a static water head. Thus, voiding is unlikely to occur in the event of pipe breaks. DCD_09.02.02-50

The COL Applicant is to develop a milestone schedule for implementation of the operating and maintenance procedures for water hammer prevention. The procedures should address the operating and maintenance procedures for adequate measures to avoid water hammer due to a voided line condition.

9.2.2.3 Safety Evaluation

The CCWS is designed to perform its safety function with only two out of four trains operating. As shown in Table 9.2.2-3, the CCWS is completely redundant and a single failure does not compromise the system's safety function even if one train is out of service for maintenance.

The safety-related portions of the CCWS is protected against natural phenomena and internal missiles. The following sections addresses natural phenomena and missiles protection.

- Section 3.3, Wind, hurricane, and tornado loadings; DCD_02-03 S01
- Section 3.4, Water Level (Flood) Protection;
- Section 3.5, Missile Protection;
- Section 3.7, Seismic Design;

Pipe rupture protection against other ruptured piping is addressed in Section 3.6, Protection against Dynamic Effects Associated with Postulated Rupture of Piping. Leakage cracks and other type of pipe rupture are not postulated in the safety-related CCWS piping because piping is designed to comply BTP 3-4 B(iii)(1)(c) and C as stated in Subsection 3.6.2.1.2.2 and 3.6.2.1.3. DCD_09.02.02-85

The CCWS continues to perform its safety function in the event of a fire. Subsection 9.5.1 addresses fire protection.

The R/B which contains safety-related portions of the CCWS is designed and constructed as a safety-related and seismic category I structure. The safety-related portions of the CCWS are designed and constructed as seismic category I.

The wet bulb design temperature is based on climatological data in accordance with RG 1.27. [[A 2°F recirculation penalty is added to the maximum average wet bulb temperature.]]

The required total water usage [[(due to cooling tower drift and evaporation) over the postulated 30 day period]] is determined using industry standard methodology as follows:

[[Total Evaporation (E) and Drift (D) rates were calculated using the ESW flow rate (GPM) times the temperature rise (CR) and a conservative cooling tower factor of 0.0009, E (total) = GPM x CR x 0.0009]].

[[a. The cooling tower factor of 0.0009 is considered conservative since it is based on standard cooling tower evaporation factor of 0.0008, and typical cooling tower drift rate of 0.0002. This is expressed as

Total Evaporation (E) = GPM x CR x 0.0008 + GPM x 0.0002]]

[[b. The ESW temperature rise (CR) was based on heat rate equation of H as Heat Rate (H) = m x specific heat x CR, where, m = mass flow rate.]]

[[c. Accumulative evaporation (gallons/cooling tower) is calculated by multiplying the evaporation rate (gpm) and its corresponding time interval.]]

d. The total water loss due to evaporation [[and drift]] for the 30 days period is calculated and is defined as the plant unit minimum required water capacity for the [[basin]] design in accordance with RG 1.27.

Using worst case heat loads during two train operation, the maximum required 30-day cooling water capacity is approximately [[8.40 million gallons]]. The minimum water level to be maintained is determined by accounting for expected debris accumulation, level instrument uncertainties and system leakage.

9.2.5.3 Safety Evaluation

The UHS is capable of rejecting the heat load under limiting conditions. The COL Applicant will provide results of UHS capability and safety evaluation of the UHS based on specific site conditions and meteorological data.

The UHS is arranged to support separation of the four divisions of ESWS. System functional capability is maintained assuming one division is unavailable due to on-line maintenance during a design basis accident with a single active failure, with or without a LOOP.

The UHS is designed to withstand the effects of natural phenomena, including the capability to remain functional following a safe shutdown earthquake (SSE). The basis for the structural adequacy of the UHSRS is provided in the following sections:

- 3.3, Wind, ~~and Tornado Loads~~Hurricane, and Tornado Loadings DCD_02-03 S01
- 3.4, Water Level (Flood) Design

- The essential chilled water system withstands the effects of adverse environmental, operating and accidental conditions.
- The essential chilled water system withstands the effects of tornadoes and hurricanes and tornado missiles and hurricane missiles. DCD_02-03 S01
- The essential chilled water system withstands the design loadings.
- The essential chilled water system meets GDC 2, by compliance, meeting the guidance of Regulatory Guide (RG) 1.29. The applicable sections of RG 1.29 include Position C.1 for safety related portions and Position C.2 for non-safety related portions.

9.2.7.1.1.2 Power Generation Design Bases

The essential chilled water system is designed to satisfy the following power generation design bases.

- The essential chilled water system supplies 40° F chilled water to the HVAC systems cooling coils during normal operation and design basis accidents.
- The essential chilled water system provides accessibility for adjustment, periodic inspection, and maintenance activities to assure continuous functional reliability.

9.2.7.1.2 Non-Essential Chilled Water System

The non-essential chilled water system is designed to meet the relevant requirements of GDC 45, and GDC 46 (Ref.9.2.11-1).

9.2.7.1.2.1 Safety Design Bases

The non-essential chilled water system, with the exception of piping and valves between and including the safety-related and seismic category I containment isolation valves, is classified as non-safety related~~, non-seismic category I system~~. This system is designed to satisfy the following safety design basis. DCD_09.02.02-70

- The non-essential chilled water system provides containment isolation of the chilled water lines penetrating the containment.
- The safety-related portion of the non-essential chilled water system meets GDC 2, by compliance, meeting the guidance of Regulatory Guide (RG) 1.29. The applicable sections of RG 1.29 include Position C.1 for safety-related portions and Position c.2 for non-safety related portions.

9.2.7.1.2.2 Power Generation Design Bases

The non-essential chilled water system is designed to satisfy the following power generation design bases.

During a SBO, the reactor coolant pumps seal integrity is maintained until the charging pumps are powered from an alternate power source and seal water injection restarts using the normal seal injection flow path.

The CVCS is designed to provide makeup for minor leaks in the RCS. The makeup capability is limited to the leakage equivalent to a pipe break with 3/8 inch inside diameter.

The CVCS does not provide an ECCS function.

CVCS components and piping are compatible with the radioactive fluids they contain and the functions they perform. The equipment classification for the CVCS is contained in Section 3.2.

The CVCS is designed to ensure that the boric acid solution remains soluble. Heat tracing or a heated area with temperature alarms are provided for portions of the system which normally contain 4 wt. % of boric acid solution, to assure that boric acid solution temperature does not go below 65 °F.

The VCT is designed to withstand vacuum conditions to prevent wall inward buckling and failure. The boric acid tanks are provided with vacuum breakers to prevent a vacuum condition. The holdup tanks are provided with sufficient nitrogen gas supply to prevent vacuum condition.

The CVCS is designed in accordance with the requirements of 10 CFR 50, Appendix A, GDCs are GDC 1, 2, 14, 33, 60, and 61. The CVCS is subjected to the design objectives of RG 4.21, "Minimization of Contamination and Radioactive Waste Generation: Life-Cycle Planning" as it contains radioactive fluids. A discussion of the design objectives and operational programs to address these radiological aspects of the system is contained in DCD Section 12.3.1. System and component design features addressing RG 4.21 (Ref. 9.3.7-13) are summarized in Table 12.3-8.

The protection of safety-related portions of CVCS against natural phenomena and internal missiles is addressed in the following sections in Chapter 3:

Section 3.3, Wind, hurricane, and tornado loadings; DCD_02-03 S01

Section 3.4, Water level (Flood) protection;

Section 3.5, Missile protection;

Section 3.7, Seismic design;

Section 3.11, Environmental qualification of mechanical and electrical equipment.

Pipe rupture protection is addressed in Chapter 3 Section 3.6, Protection against Dynamic effects associated with postulated rupture of piping.

9.3.4.4 Inspection and Testing Requirements

In-service inspection and testing of ASME Code Classes 2 and 3 components is discussed in Chapter 6, Section 6.6. Chapter 3, Subsection 3.9.6 discusses in-service

- RGs, 1.29, 1.52, 1.78, 1.155, 1.196, 1.197, and 4.21
- ANSI/ANS 51.1, 59.2
- ASME N509, N510, AG-1
- IEEE 323, 344, 603

9.4.1.1 Design Bases

9.4.1.1.1 Safety Design Bases

The MCR HVAC System is designed to:

- Exclude entry of airborne radioactivity into the CRE and remove radioactive material from the CRE environment such that radiation dose to MCR personnel is within the GDC 19 (Chapter 6, Section 6.4).
- Support and maintain CRE habitability and permit personnel occupancy and proper functioning of instrumentation during normal and design basis accidents, assuming a single active failure (Chapter 6, Section 6.4).
- Withstand the effects of adverse environmental conditions.
- Withstand the effects of tornadoes and hurricanes and tornado missiles and hurricane missiles. DCD_02-03 S01
- Withstand the effects of seismic events. The MCR HVAC system equipment and the associated ductwork are designed to seismic category I requirements.
- Provide the MCR personnel protection by detecting and preventing the introduction of smoke into the CRE by automatically aligning the system to the emergency isolation mode (Chapter 6, Section 6.4).
- Automatically switch from normal operating mode to emergency pressurization mode upon the MCR isolation signal (Chapter 7).

The emergency filtration units are designed and constructed in accordance with ASME standard N509 (Ref. 9.4.8-1), AG-1 (Ref. 9.4.8-2) and with the recommendations of RG 1.52 (Ref. 9.4.8-3).

Proper MCR personnel protection against toxic gases is described in Chapter 6, Section 6.4.

9.4.1.1.2 Power Generation Design Bases

The MCR HVAC System is designed to:

- Maintain the CRE under proper ambient conditions (Table 9.4-1) to assure personnel comfort during normal operation and to support the continuous operation of the plant control and instrumentation equipment and components.

- Provide accessibility to system components for adjustment, maintenance and periodic inspection and testing of the system components to assure proper equipment function and reliability and system availability.

The MCR HVAC System stops for one hour after SBO occurs until alternate ac gas turbine generator restores power. However, all Class 1E cabinets are designed to keep their integrity during loss of a HVAC system (Chapter 8, Section 8.4).

9.4.1.2 System Description

The MCR HVAC system is shown in Figure 9.4.1-1 and system equipment and components design data are presented in Table 9.4.1-1. The COL Applicant is to determine the capacity of heating coil that are affected by site specific conditions. The MCR HVAC system consists of two redundant 100% emergency filtration units and four 50% capacity air handling units, two 100% toilet/kitchen exhaust fans, one 100% smoke purge fan, ductwork, associated damper and instrumentation and control. The air handling units are connected to a common overhead air distribution ductwork system. The ductwork delivers the conditioned air of 11,000 cfm to MCR and 9,000 cfm to other rooms (i.e. file room, shift supervisor's room, conference room, break room, kitchen and restroom).

Any two of the four 50% capacity air handling units have the capacity to satisfy the operating requirements of the CRE during normal and design basis accidents. The outside air intakes, exhaust line and smoke purge line are provided with ~~tornado missile~~ tornado/hurricane missile protection grids and tornado depressurization protection dampers. The CRE is also served by two 100% capacity toilet/kitchen exhaust fans and one smoke purge fan. The back draft damper is provided in the outlet of toilet/kitchen exhaust fan to prevent short circuiting of exhaust airflow. Non-safety related electric in-duct heaters and a humidifier that are designed as seismic Category II are located in the duct branches leading to the MCR. DCD_02-03 S01

Each of the 50% capacity air handling units is classified as equipment class 3, seismic category I and consists of, in the direction of airflow, a low efficiency pre-filter, a high efficiency filter, an electric heating coil, a chilled water cooling coil, and a supply fan. Each air-handling unit is provided with isolation dampers, MCR air handling unit inlet and outlet damper, at the inlet and outlet. The air handling units are provided with safety related, seismic category I equipment drain lines. DCD_06.04-16

Each of the 100% capacity emergency filtration units and emergency filtration unit fans is classified as equipment class 3, seismic category I. The emergency filtration unit consists of, in the direction of airflow, a high efficiency filter, an electric heating coil, a HEPA filter, a charcoal adsorber, a high efficiency filter and a supply fan. Each emergency filtration unit is provided with isolation dampers, MCR emergency filtration air intake, air return and fan outlet damper, at the inlet and outlet.

Upon the MCR high temperature, the chilled water control valve for the activated air handling units is automatically positioned for full chilled water flow to prevent the temperature rise.

9.4.1.3 Safety Evaluation

The continuous operation of the MCR HVAC system is assured by the physical separation of the redundant air handling units and components. All system equipment and components, with the exception of the toilet/kitchen exhaust and smoke purge fans and the in-duct heater electric heating coils, are classified as equipment class 3, seismic category I.

In the event of a design basis accident coincident with a LOOP, the air handling units and emergency filtration units are powered from their respective Class 1E power supplies to ensure system operation.

Redundant equipment and components are powered by separate Class 1E buses. The air handling units are served by the essential chilled water system. As shown in Table 9.4.1-2, failure of a single active component in one air handling unit cannot result in complete loss of heating or cooling of the CRE.

The MCR HVAC system is capable of maintaining the CRE air temperature within the specified limits (Table 9.4-1) under abnormal plant operation.

Each of the two redundant safety-related emergency filtration units is sized to assure that the MCR operator's radiological dose shall not exceed the limits set by GDC 19. The MCR operator doses are calculated in accordance with the methodology and accidents identified in RG 1.195 (Ref. 9.4.8-4) or 1.183 (Ref. 9.4.8-5) and inleakage value as determined using RG 1.197 (Ref. 9.4.8-6).

The MCR emergency filtration units are engineered safety features that are designed as a part of the fission product removal system.

Redundant safety-related Class 1E radiation monitors are located in the outside air intake duct to automatically switch the MCR HVAC system from the normal operation mode to the emergency pressurization mode upon detection of a radiological level higher than a predetermined value. The habitability of the MCR following design basis accidents is further described in Chapter 6, Section 6.4.

In the event of fire and smoke presence in the CRE, smoke detectors alarms in the MCR. If required, the operator can initiate the smoke purge mode when the emergency mode is not in effect.

System's air supply and exhaust fan housings are designed to resist penetration of internally generated missiles in the event of a fan rotor failure.

The MCR HVAC system equipment and components are protected from tornado-generated missiles and hurricane-generated missiles by their location inside a seismic category I structure. DCD_02-03 S01

The MCR HVAC system's outside air intakes and exhaust outlets are protected from tornado-generated missiles and hurricane-generated missiles by specially designed protective ~~gratings~~barriers. Refer to Section 3.5.3.1.1. These protective barriers are part of the R/B structure outer wall and have the following dimensions: thicknesses of greater than or equal to 20 inches for the vertical sections and greater than or equal to 14 inches DCD_02-03 S01 DCD_14.03.07-59

- The ESF ventilation system is classified as a safety-related and seismic category I system.
- Redundant ventilation systems are powered by separate safety related buses so that a failure of a single active component cannot result in loss of cooling for the served areas.
- The system is capable of performing the intended design functions assuming a single active component failure coincident with a LOOP.
- The system can withstand the effects of adverse environmental conditions.
- The system can withstand the effects of tornado depressurization and tornado-generated missiles and hurricane-generated missiles. DCD_02-03 S01
- 10 CFR 50, Appendix A, GDC 17 is satisfied in part for the essential electrical components of the ESF Ventilation System, such as contacts and relays. This is accomplished by protecting the components from accumulated dust and particulate materials by enclosing the components in dust-tight cabinets and taking outdoor air through air filters from a height of at least 7 meters (20 feet) above ground level.

9.4.5.1.1.1 Annulus Emergency Exhaust System

During normal plant operation, the penetration areas are served by the auxiliary building HVAC system (Section 9.4.3). During a design basis accident, the safety-related isolation dampers automatically isolate the supply and exhaust line of the auxiliary building HVAC system. The annulus emergency exhaust system is designed to satisfy the following design basis.

- The emergency exhaust filtration units are designed and constructed in accordance with ASME standard N509 (Ref. 9.4.8-1), AG-1 (Ref. 9.4.8-2) and with the recommendations of RG 1.52 (Ref. 9.4.8-3).
- The system is designed to mitigate the consequences of postulated accidents by removing the airborne radioactive material that may leak from containment.
- The system remains functional during and after a design basis accident.
- The system maintains a negative pressure in the penetration and safeguard comportment areas relative to the adjacent areas (Chapter 6, Section 6.5.1).

9.4.5.1.1.2 Class 1E Electrical Room HVAC System

The Class 1E electrical room HVAC system is designed to satisfy the following design basis.

- Maintain proper operating environmental conditions within the Class 1E electrical rooms (Table 9.4-1) during normal and design basis accident.

Each system includes a Class 1E electrical room air handling unit, a Class 1E electrical room return air fan, a Class 1E battery room exhaust fan, an outside air intake and exhaust outlets with a ~~tornado missile~~tornado/hurricane missile protection grid and a tornado depressurization protection damper. All components are qualified as equipment class 3, seismic category I. The air handling unit of each system consists of, in the direction of airflow, a low efficiency filter, a high efficiency filter, an electric heating coil, a chilled water cooling coil, a supply fan, and associated controls. The cooling coil of each system's air handling unit is supplied with chilled water from the corresponding essential chilled water system (Section 9.2.7). Return air from the electrical room is drawn through the return air ductwork by the system's return air fans. Both air handling units are connected to a common air distribution duct through their discharge air isolation dampers. DCD_02-03 S01

Train pair A&B and train pair C&D, each is connected to a single air distribution system. The air distribution system is qualified in accordance with seismic category I requirements. Conditioned air is distributed to the following areas:

- Class 1E instrumentation and control (I&C) rooms
- Class 1E electrical rooms
- Class 1E uninterruptible power supply (UPS) rooms
- Class 1E Battery and battery charger rooms
- MCR/Class 1E electrical HVAC equipment rooms
- Remote shutdown console room
- Control rod drive mechanism (CRDM) cabinet room (non-safety)
- M-G set and M-G set panel rooms (non-safety)
- Leakage rate testing (LRT) room (non-safety)
- Reactor trip breaker room
- AAC selector circuit panel room

The return air from these areas is drawn by the corresponding HVAC train through the seismic category I ductwork.

The volume of the air exhausted from battery rooms by the corresponding battery exhaust fans is sufficient to maintain the hydrogen concentration well below 1% by volume of battery room.

The safety-related in-duct heaters are provided in supply air branches to remote shutdown console room, Class 1E battery rooms, Class 1E I&C rooms and MCR/Class 1E electrical HVAC equipment rooms. These electric heaters are classified as equipment class 3 and seismic category I.

The emergency feedwater pump (motor-driven) area air handling unit consists of, in the direction of airflow, an electric heating coil, a cooling coil, a supply fan, and associated controls. The emergency feedwater pump (turbine-driven) area HVAC system includes outside air intakes and exhaust outlets with a ~~tornado missle~~tornado/hurricane missile protection grid and a tornado depressurization protection damper. The emergency feedwater pump area HVAC system is shown in Figure 9.4.5-4 and the equipment design data is presented in Table 9.4.5-1. The COL Applicant is to determine the capacity of heating coils that are affected by site specific conditions. The cooling coils of the emergency feedwater pump area air handling units are supplied with chilled water from the essential chilled water system (Section 9.2.7). DCD_02-03 S01

Each of the air handling units provides 100% of the heating and cooling requirements of the associated equipment room.

Upon the emergency feedwater pump area high temperature, the chilled water control valve for the corresponding air handling units is automatically positioned for full chilled water flow to prevent the temperature rise.

Upon the electric heating coil outlet high temperature, the electric heating coil is automatically tripped to prevent the abnormal heating.

9.4.5.2.5 Safety Related Component Area HVAC System

During normal plant operation ESF equipment areas are served by the auxiliary building HVAC system (Section 9.4.3). During a design basis accident or LOOP, the auxiliary building HVAC system is unavailable. The safety related component areas are cooled by individual air handling units. A rise of the safety related component area temperature reaching the setpoint of the switch is to cause the associated fan to start. Reverse operation occurs upon a temperature decrease below the setpoint of the switch.

Each of the air handling units in the penetration areas, CCW pump areas, essential chiller unit areas and charging pump areas, each consists of, in the direction of airflow, an electric heating coil, a cooling coil, a supply fan, and associated controls. Each of the air handling units provides 100% of the heating and cooling requirements of the associated equipment room.

Each of the air handling units in the annulus emergency exhaust filtration areas and spent fuel pit pump areas, consists of, in direction of airflow, an electric heating coil, two cooling coils, a supply fan, and associated controls. Each of the air handling units provides 100% of the heating requirements of the associated equipment room. Each of the air handling units contains two 100% capacity cooling coils. Each cooling coil is served by a dedicated train of the essential chilled water system. Hence, the loss of one train will not affect the cooling capacity of the annulus emergency filtration unit area and spent fuel pit pump area air handling units.

The safety-related component area HVAC system is shown in Figure 9.4.5-1 and 9.4.5-5 and the equipment design data is presented in Table 9.4.5-1. The COL Applicant is to determine the capacity of heating coils that are affected by site specific conditions. The cooling coils are supplied with chilled water from the essential chilled water system (Section 9.2.7).

Upon safety-related component area high temperature, the chilled water control valve for the corresponding air handling units is automatically positioned for full chilled water flow to prevent the temperature rise.

Upon electric heating coil outlet high temperature, the electric heating coil is automatically tripped to prevent the abnormal heating.

9.4.5.3 Safety Evaluation

9.4.5.3.1 Annulus Emergency Exhaust System

- This system has two 100% capacity emergency exhaust filtration units, each capable of performing its safety function under all associated design basis accidents coincident with a LOOP.
- The safety function of the annulus emergency exhaust filtration units are assured by the physical separation of its redundant trains and components. All system equipment and components are classified as equipment class 2, seismic category I.
- The redundant units are powered by separate Class 1E buses. As shown in Table 9.4.5-2, failure of a single active component in one of the annulus emergency exhaust filtration units cannot result in a loss of the system's safety function.
- The annulus emergency exhaust system equipment and components are protected from tornado generated missiles and hurricane generated missiles by their location inside a seismic category I structure. DCD_02-03 S01
- The adverse effects associated with the tornado depressurization of the air exhaust line are prevented by the specially designed tornado damper in the exhaust line.
- All duct penetrations in firewalls are protected by rated fire dampers to prevent the spread of fire from the affected area to the adjacent redundant component areas.

9.4.5.3.2 Class 1E Electrical Room HVAC System

- The continuous operation of the Class 1E electrical rooms HVAC system is assured by the physical separation of its redundant trains and components. All system equipment and components are classified as equipment class 3, seismic category I.
- Redundant equipment and components are powered from separate Class 1E buses. The air handling units are served by the essential chilled water system. As shown in Table 9.4.5-2, failure of a single active component in one air handling unit cannot result in complete loss of heating or cooling of the class 1E electrical rooms.
- The battery rooms are ventilated with sufficient supply and exhaust airflow during all modes of operation in order to limit the hydrogen concentration below 1%

percent by volume of battery room. A back up battery room fan starts automatically upon detection of the running fan airflow failure.

- All duct penetrations in fire walls are protected by fire dampers to prevent the spread of fire from the affected area to the adjacent redundant component areas.

- Systems air supply, return and exhaust fan housings are designed to resist penetration of internally generated missiles in the event of fan rotor failure.

- The Class 1E electrical room HVAC system equipment and components are protected from tornado-generated missiles and hurricane-generated missiles by their location inside a seismic category I structure. DCD_02-03 S01

- The system's outside air intakes and exhaust outlets are protected from the externally tornado generated missiles and hurricane generated missiles by specially designed protective ~~gratings~~barriers. Refer to Section 3.5.3.1.1. These protective barriers are part of the R/B structure outer wall and have the following dimensions: thicknesses of greater than or equal to 20 inches for the vertical sections and greater than or equal to 14 inches for the horizontal section; and width and height greater than the corresponding dimension of the respective ventilation opening. DCD_02-03 S01 DCD_14.03.07-59

- The adverse effects associated with the tornado depressurization of the outside air intakes and exhaust openings are prevented by the specially designed tornado dampers located at the outside air intakes and exhaust opening.

9.4.5.3.3 Safeguard Component Area HVAC System

- The operation of the safeguard component area HVAC system is assured by the physical separation of its redundant equipment and components. All system equipment and components are classified as equipment class 3, seismic category I.

- In the event of a design basis accident coincident with a LOOP, the safety-related air handling units receive emergency power from the corresponding safety buses to ensure the availability of cooling of the safeguard component areas. Failure mode and effects analysis Table 9.4.5-2 concludes that no single failure coincident with a LOOP compromise the system's safety functions.

- Air handling unit fan housings are designed to resist penetration of internally generated missiles in the event of fan rotor failure.

- All duct penetrations in firewalls are protected by rated fire dampers to prevent the spread of fire from the affected area to the adjacent redundant component areas.

9.4.5.3.4 Emergency Feedwater Pump Area HVAC System

- The operation of the emergency feedwater pump area HVAC system is assured by the physical separation of its redundant equipment and components. All system equipment and components are classified as equipment class 3, seismic category I.

- In the event of a design basis accident, coincident with a LOOP, the safety-related air handling units receive emergency power from the corresponding safety buses to ensure the availability of cooling of the emergency feedwater pump areas. Failure mode and effects analysis Table 9.4.5-2 concludes that no single failure coincident with a LOOP compromises the system's safety functions.

- Air handling unit fan housings are designed to resist penetration of internally generated missiles in the event of fan rotor failure.

- All duct penetrations in firewalls are protected by rated fire dampers to prevent the spread of fire from the affected area to the adjacent redundant component areas.

- The emergency feedwater pump (turbine-driven) area HVAC system equipment and components are protected from tornado-generated missiles and hurricane-generated missiles by their location inside a seismic category I structure. DCD_02-03 S01

- The system's outside air intakes and exhaust outlets are protected from the externally tornado generated missiles and hurricane generated missiles by specially designed protective ~~gratings~~barriers. Refer to Section 3.5.3.1.1. These protective barriers are part of the R/B structure outer wall and have the following dimensions: thicknesses of greater than or equal to 20 inches for the vertical sections and greater than or equal to 14 inches for the horizontal section; and width and height greater than the corresponding dimension of the respective ventilation opening. DCD_02-03 S01 DCD_14.03.07-59

9.4.5.3.5 Safety Related Component Area HVAC System

- The operation of the safety related component HVAC system is assured by the physical separation of its redundant equipment and components. All system equipment and components are classified as equipment class 3, seismic category I.

- In the event of a design basis accident coincident with a LOOP, the safety-related air handling units receive emergency power from the corresponding safety buses to ensure the availability of cooling of the safety-related component areas. Failure mode and effects analysis Table 9.4.5-2 concludes that no single failure coincident with a LOOP compromises the system's safety functions.

- Air handling unit fan housings are designed to resist penetration of internally generated missiles in the event of fan rotor failure.

- All duct penetrations in firewalls are protected by rated fire dampers to prevent the spread of fire from the affected area to the adjacent redundant component areas.

9.4.5.4 Inspection and Testing Requirements

The ESF ventilation system is provided with adequate instrumentation, temperature, flows, and differential pressure indicating devices to facilitate testing and verification of equipment heat transfer capability and flow blockage.

Ductwork is supported, as required, to prevent adverse interaction with safety-related systems during a seismic event per RG 1.29.

9.4.6.1.1 Safety Design Bases

The containment ventilation system is designed to satisfy the following design bases:

- The containment purge system has the capability to close the safety-related, seismic category I, containment isolation valves during a design basis accident.
- The safety-related containment isolation valves isolating the containment are connected to separate electrical safety buses that satisfy the single active failure criterion.
- The containment isolation valves assemblies are design to withstand the effect of adverse environment conditions.
- The containment ventilation system meets GDC 2 by being located within seismic Category I and II structures and by compliance to Regulatory Guide (RG) 1.29, position C.1 for safety-related portions and position C.2 for non-safety-related portions. The containment and the reactor building contain the safety-related portions of the containment ventilation system and are protected from the effects of natural phenomena such as earthquakes (Section 3.7), wind, hurricane, and tornados (Section 3.3), floods (Section 3.4), and external missiles (Section 3.5). DCD_02-03 S01
- During a design basis accident, air operated valves (VAS-AOV-511-S and VAS-AOV-512-S) isolate the auxiliary building HVAC system discharge duct, which the containment purge system is tied into, in order to prevent the backflow of discharge air from the annulus emergency exhaust system into the auxiliary building HVAC system and the containment purge system. DCD_12.03-12.04-37

9.4.6.1.2 Power Generation Design Bases

9.4.6.1.2.1 Containment Fan Cooler System

The containment fan cooler system is designed to satisfy the following design bases:

- Maintain containment air temperature below 120° F (Table 9.4-1) during normal plant operation and below 150° F during LOOP condition.
- Provide proper air distribution.
- Provide standby for the active containment fan coolers to ensure continuous and reliable performance during normal plant operation.
- During a LOOP condition, the containment fan coolers are served by the alternate ac power source.

recommendation. Strainers may be removed and inspected for the buildup of impurities on a periodic basis.

9.5.7.5 Instrumentation Requirements

Instrumentation provided for the lubrication system includes pressure and temperature switches and indicators. Low lube oil pressure and high lube oil temperatures, are alarmed in the MCR and in the GTG room. In addition, local indications associated with the lubrication system that are provided, including oil temperature and pressure.

Lube oil tank level instrumentation is installed and low level is alarmed in the MCR and in the GTG room. Differential pressure instrumentation for filter and strainer are installed and high pressure is alarmed the MCR and in the GTG room. Low lube oil pressure and high lube oil temperature during operation of the GTG initiates a GTG trip, without postulated accident condition. GTG oil pressure and oil temperature trip logic initiates a GTG trip and alarms at the GTG control panel and the MCR. Both of these sensors are connected to common supply piping for No.1 bearing and No.2 bearing.

Setpoints for instrumentation associated with the lubrication system are in accordance with the GTG manufacturer's recommendations. During surveillance testing, any alarm condition would be immediately verified by the operator utilizing instrumentation at the GTG location.

9.5.8 GTG Combustion Air Intake, Turbine Exhaust, Room Air Supply, and Air Exhaust Systems

A GTG combustion air intake and turbine exhaust system for each of the four GTGs supply combustion air of reliable quality to the gas turbine and exhausts combustion products from the gas turbine to the atmosphere. The room air supply and air exhaust provides ventilation/cooling air to the GTG assembly. Each GTG consists of two gas turbines that drive one generator through one gearbox.

9.5.8.1 Design Bases

Protection of the GTG combustion air intake, turbine exhaust, room air supply and air exhaust system from wind, hurricane, and tornado effects is discussed in Section 3.3. DCD_02-03 S01
Flood design is discussed in Section 3.4. Missile protection is discussed in Section 3.5. Protection against dynamic effects associated with postulated rupture of piping is discussed in Section 3.6. Environmental qualification is discussed in Section 3.11.

- The combustion air intake and turbine exhaust system is capable of supplying adequate combustion air and disposing of resultant exhaust products to permit continuous operation of the GTGs for each unit at 110% of nameplate rating.

- The combustion air intake and turbine exhaust system is designed to remain functional during and after a SSE.

- The combustion air intake and turbine exhaust system is designed so that a single failure of any component, assuming a LOOP, cannot result in complete loss of the power source.

9.5.8.2.2.3 Piping/ducts

The intake piping~~, weather louver~~ and screens are provided to supply combustion air to each GTG. DCD_09.05.08-28

The turbine and air exhaust piping is made of carbon steel. Duct work is made of galvanized steel. Expansion joints are strategically located to accommodate the thermal growth of the exhaust piping. The piping is of adequate size so that it can accommodate the total pressure drop when the engine is operating at 110% of continuous rating.

9.5.8.2.3 System Operation

Upon initiation of a GTG start signal, combustion air is drawn into the air intake ~~weather louver and~~ screens and passes through the intake piping to the GT intake duct. The combustion air intake ~~weather louver and~~ screens, silencer, and the combustion air piping are sized to supply an adequate supply of air to the GT while operating at 110% of nameplate rating. The turbine exhaust gases enter the turbine exhaust pipe, pass through the turbine exhaust silencer, and are then ducted out of the building. The exhaust piping and silencer are sized to prevent excessive backpressure on the engine when operating at 110% nameplate rating. DCD_09.05.08-28

Cooling air is supplied and exhausted out of the building through the air exhaust piping.

9.5.8.3 Safety Evaluation

A. The GTG combustion air intake and exhaust system is capable of supplying an adequate quantity of combustion air to the GT and of disposing the exhaust gases without creating an excessive backpressure on the GT when operating at 110% of nameplate rating. Cooling air is supplied to the GTG and exhausted from the building.

   The power source buildings (PS/Bs) are equipped with a fire suppression system.

   US-APWR power block general arrangement drawings (Chapter 1) show the physical relationship of the PS/B to those plant features, which could affect the system. The PS/B is not located near any gas storage facilities. The hydrogen storage facility is 600 ft. away, and the nitrogen bulk storage is 600 ft. away.

   The distances between the PS/B and those facilities are adequate to ensure that an accidental release of these gases does not degrade GTG performance.

   The turbine intake and exhaust openings above the roof of the PS/B, and the portion of the piping/ducts above the roof is protected by a guard structure against precipitation, ~~and~~ tornado missiles and hurricane missiles. The reinforced concrete guard structures are integrally attached to the roofs and act as extensions of the seismic category I PS/Bs. The guard structures are designed as seismic category I to withstand the effects of natural phenomena in accordance with GDC 2 and to withstand environmental effects in accordance with GDC 4. The turbine exhaust is located appropriately away from the engine air intake, DCD_02-03 S01

10.3 Main Steam Supply System

The main steam supply system (MSS) as described in this section runs from the US-APWR steam generator nozzle up to the main turbine stop valve, including the branch piping.

The main function of the MSS is to transport steam from the steam generators (SGs) to the high-pressure turbine and to the moisture separator reheater over a range of flows and pressures covering the entire operating range from system warmup to valve wide open (VWO) turbine conditions.

The system also supplies steam to the main turbine gland seal system, the emergency feedwater (EFW) pump turbine(s), the deaerator heater (heater no. 5) and the auxiliary steam supply system (ASSS). The system also dissipates heat generated by the nuclear steam supply system (NSSS) by means of turbine bypass valves (TBV) to the condenser or to the atmosphere through air-operated main steam relief valves (MSRV), or the motor-operated main steam depressurization valves (MSDV) or the spring-loaded main steam safety valves (MSSV) when either the turbine-generator or condenser is unavailable.

10.3.1 Design Bases

10.3.1.1 Safety Design Bases

The system is provided with a main steam isolation valve (MSIV) and an associated main steam bypass isolation valve (MSBIV) in each main steam line. These valves isolate the secondary side of the SGs to prevent the uncontrolled blowdown of more than one SG and isolate non safety-related portions of the system.

The MSS safety design bases are as follows:

Conformance to GDC 2 (Reference 10.3-1) assures that the SSC of the MSS can withstand the effects of natural phenomena, hence guaranteeing the capability of the system to perform its safety functions. The safety-related portions are protected from the effects of wind, ~~and~~ tornado and hurricane as described in Section 3.3; flood protection as described in Section 3.4; and seismic design as described in Section 3.7. DCD_02-03 S01

Conformance to GDC 4 (Reference 10.3-1) assures that the safety-related SSC of MSS are resistant to the effects of the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents, including LOCAs. The design includes suitable protection so that dynamic effects, including internally generated missiles, pipe whipping, and discharging fluids due to equipment malfunctions and external events do not pose a threat to system integrity. The safety-related portions are protected from missile protection as described in Section 3.5; protection against dynamic effects associated with the postulated rupture of piping as described in Section 3.6; and environmental design as described in Section 3.11.

The isolation valves close after receipt of an isolation signal to limit the mass and energy release to containment consistent with the containment analysis presented in Chapter 6.

The safety-related portions of the FWS are designed to remain functional during and after a safe-shutdown earthquake (SSE) and to perform their intended function of isolating feedwater flow following postulated events.

Conformance to GDC 2 (Reference 10.4-1) assures that the SSC of the CFS can withstand the effects of natural phenomena, hence guaranteeing the capability of the system to perform its safety functions. The safety-related portions are protected from the effects of wind, ~~and~~ tornado and hurricane as described in Section 3.3; flood protection as described in Section 3.4; and seismic events as described in Section 3.7. DCD_02-03 S01

Conformance to GDC 4 (Reference 10.4-1) assures that the safety-related SSC of CFS are resistant to the effects of the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents, including LOCAs. The design includes suitable protection so that dynamic effects, including internally generated missiles, pipe whipping, and discharging fluids due to equipment malfunctions; and external events do not pose a threat to system integrity. The safety-related portions are protected from missile protection as described in Section 3.5; protection against dynamic effects associated with the postulated rupture of piping as described in Section 3.6; and environmental design as described in Section 3.11.

In conformance with GDC 5 (Reference 10.4-1), no equipment the CFS is shared between safety-related units to preclude consequential effects of malfunctioning components within the system.

In conformance with GDC 44 (Reference 10.4-1), the CFS has sufficient redundancy for heat removal in conjunction with MSS, and is designed to permit appropriate periodic inspection of important components for conformance to GDC 45 (Reference 10.4-1).

In conformance with GDC 46 (Reference 10.4-1), the CFS is designed to permit appropriate functional testing of the system and components to ensure structural integrity and leak-tightnes.

The FWS' intended safety functions can be performed, assuming a single active component failure coincident with the loss of offsite power.

The portion of the FWS to be constructed in accordance with ASME Code, Section III (Reference 10.4-8), Class 2 requirements allows access to welds and uses removable insulation for inservice inspection, in accordance with ASME Code, Section XI (Reference 10.4-12). The portion of the FWS to be constructed in accordance with ASME Code, Section III (Reference 10.4-8), Class 3 requirements is also designed and configured to accommodate inservice inspection in accordance with ASME Code, Section XI (Reference 10.4-12).

The control functions and power supplies are described in Chapters 7 and 8, respectively.

10.4.8 Steam Generator Blowdown System

The steam generator blowdown system (SGBDS) assists in maintaining secondary side water chemistry within acceptable limits during normal plant operation and during anticipated operational occurrences (AOO) due to the main condenser in leakage or primary to secondary steam generator tube leakage. This is done by removing impurities concentrated in steam generators by continuous blowdown of secondary side water from the steam generators. The system processes blowdown water from all steam generators, as required.

The SGBDS is subjected to the design objectives of RG 4.21, "Minimization of Contamination and Radioactive Waste Generation: Life-Cycle Planning" as it may contains radioactivity due to the main condenser in leakage and/or primary to secondary steam generator tube leakage. A discussion of the design objectives and operational programs to address these radiological aspects of the system is contained in DCD Section 12.3.1. System and component design features addressing RG 4.21 (Ref. 10.4-20) are summarized in Table 12.3-8.

10.4.8.1 Design Bases

10.4.8.1.1 Safety Design Bases

The safety-related design bases of the SGBDS are as follows:

- The system is provided with a containment isolation valve in each blowdown line from the steam generators.
- The system is provided with two isolation valves in series. These valves isolate the secondary side of the steam generator to preserve the steam generator inventory. This provides a heat sink for a safe shutdown or to mitigate consequences of a design-basis accident.
- The SGBDS performs its safety-related function assuming a single active component failure coincident with the loss-of-offsite or onsite power.
- Piping and valve up to and including the outside containment isolation valve, are designed to ASME Code, Section III (Reference 10.4-8), Class 2, and Seismic Category I requirements. The blowdown system piping and valve from the outlet of the containment isolation valve up to and including first restraint located in the main steam/feedwater piping area are designed in accordance with ASME Code, Section III (Reference 10.4-8), Class 3 and Seismic Category I requirements.
- The safety-related portion of the SGBDS is designed to withstand the effects of a safe-shutdown earthquake and to perform its intended function following a DBA. The system is protected against wind, ~~and~~ tornado and hurricane effects as described in Section 3.3, flood protection as described in Section 3.4, and missile protection as described in Section 3.5, seismic design as described in Section 3.7 and fire protection as described in Subsection 9.5.1. DCD_02-03 S01

10.4.9 Emergency Feedwater System

The emergency feedwater system (EFWS) is designed to supply feedwater to the steam generators (SG) whenever the reactor coolant temperature is above 350°F and the feedwater system is not in operation. The EFWS is designed to remove reactor core decay heat and reactor coolant system (RCS) sensible heat through the SGs following transient conditions or postulated accidents such as a reactor trip, loss of main feedwater, main steam line breaks (MSLB) or feedwater line breaks (FLB), loss of offsite power (LOOP), small break loss of coolant accident (small break LOCA), station blackout (SBO), anticipated transient without scram (ATWS) and steam generator tube rupture (SGTR). The EFWS is not normally used during normal plant startup and normal plant cooldown.

The EFWS consists of two motor-driven pumps, two steam turbine-driven pumps, two emergency feedwater pits, piping, valves and associated instrumentation. The EFWS is an ASME Code, Section III (Reference 10.4-8), Classes 2 and 3, Seismic Category I, redundant system with Class 1E electric components as indicated in Table 3.2.2. The EFWS design meets the requirements of II.E.1.1 relating to reliability evaluation of the EFWS and II.E.1.2 of NUREG-0737 (Reference 10.4-13) regarding the automatic and manual initiation and flow rate indication of the EFWS.

The EFWS supplies feedwater to the SGs at a sufficient flowrate to meet the requirements for the transient conditions or postulated accidents and hot standby. Flowrate is controlled as necessary to maintain stable plant conditions by the motor-operated emergency feedwater control valves.

10.4.9.1 Design Basis

The EFWS design bases to meet the safety-related functional requirements are provided below:

- The EFWS is designed to remain functional after a safe-shutdown earthquake (SSE). The essential portions of the EFWS components are designed to Seismic Category I requirements and are located inside the reactor building which is designed for seismic, wind, ~~and~~ tornado and hurricane effects. See Sections 3.2, 3.3, and 3.9. DCD_02-03 S01

- The EFWS components and piping have sufficient physical separation and shielding to protect against the effects of postulated missiles. Protection of the essential portions of the EFWS from the effects of internally and externally generated missiles is discussed in Section 3.5.

- The functional performance of the EFWS is not affected by environmental conditions, internal flood, pipe whip or jet impingement that may result from high or moderate energy piping breaks or cracks. The building where the EFWS components are located is designed for and provided with suitable flood protection during abnormally high water levels (adequate flood protection considering the probable maximum flood) to ensure functional capability. Flood protection is discussed in Section 3.4. Protection against the effects of pipe whip turbine-driven EFW pumps are designed to be available for station blackout condition. At a minimum, the plant is designed to withstand the loss of all ac power for at least 8 hours. The plant design capabilities to cope during SBO condition are discussed in Section 8.4.

Conformance to GDC 2 (Reference 10.4-1) assures that the EFWS can withstand the effects of natural phenomena, hence guaranteeing the capability of the system to perform its safety functions. The safety-related portions are protected from the effects of wind, ~~and~~ tornado and hurricane as described in Section 3.3; flood as described in Section 3.4; and seismic events as described in Section 3.7. The guidance provided in US Nuclear Regulatory Commission (NRC), Regulatory Guide (RG) 1.29, Seismic Design Classification (Reference 10.4-9), is used for identifying and classifying those SSC as described in Section 3.2. DCD_02-03 S01

Conformance to GDC 4 (Reference 10.4-1) assures that the safety-related components of the EFWS are resistant to the effects of environmental conditions associated with normal operation, maintenance, testing, and postulated accidents, including LOCAs. The design includes suitable protection so that dynamic effects, including internally generated missiles, pipe whipping, and discharging fluids due to equipment malfunctions and external events do not pose a threat to system integrity. The safety-related portions of the EFWS are protected from missiles as described in Section 3.5; against dynamic effects associated with the postulated rupture of piping as described in Section 3.6; and environmental design as described in Section 3.11.

In conformance with GDC 5 (Reference 10.4-1), no EFWS equipment is shared between safety-related units to preclude consequential effects of malfunctioning components within the system.

In conformance with GDC 19 (Reference 10.4-1), a MCR is provided for the control of the US-APWR plant from which actions can be taken to operate the nuclear power plant safely under normal conditions and to maintain it in a safe manner under accident conditions, including LOCAs.

Conformance to GDC 34 (Reference 10.4-1) assures the redundant cooling capacity and pressure relief capability of the EFWS in conjunction with main steam supply system so that the components retain their safety functions in the event of single component failures.

In conformance with GDC 44 (Reference 10.4-1), the EFWS has sufficient redundancy for heat removal in conjunction with the MSS, and is designed to permit appropriate periodic inspection of important components in conformance with GDC 45 (Reference 10.4-1).

In conformance with GDC 46 (Reference 10.4-1), the EFWS is designed to permit appropriate functional testing of the system and components to ensure their structural integrity and leak-tightnes.

The automatic initiation signals and circuits are designed so that their failure does not result in the loss of the ability to manually initiate initiation from the control room in

Table 12.3-8 Regulatory Guide 4.21 Design Objectives and Applicable DCD Subsection Information for Minimizing Contamination and Generation of Radioactive Waste (Sheet 1 of 75)

Fuel Storage and Handling **(Note: The "System Features" column consists of excerpts/summary from the DCD)**

Objective		**System Features**	**DCD Reference**
1	Minimize leaks and spills and provide containment in areas where such events may occur.	New and spent fuel storage facilities are located in the fuel handling area of the Reactor Building (R/B) which is designed to meet the Seismic Category I requirements of Regulatory Guide (RG) 1.29.	9.1.1.1 9.1.2.2.2
		The fuel storage and handling area is protected against natural phenomena. The robust concrete walls and ceiling surrounding the fuel storage and handling area are designed to withstand the loads and forces caused by wind, tornadoes, hurricanes, floods, and external missiles.	9.1.1.1 9.1.2.2.2
		The spent fuel storage pit is constructed of reinforced concrete lined with stainless steel plate. Similarly, the refueling canal, fuel inspection pit, and cask pit are constructed of reinforced concrete lined with stainless steel plate. The SFP is lined with stainless steel. The liner surface will have a 2B or higher finish, selected to minimize accumulation of corrosion and fission products, and also provide easy maintenance and decontamination. This liner surface is smooth and non-porous to avoid buildup of radioactive material.	9.1.2.2.2
		Penetrations for the drain and makeup lines are located to preclude the draining of the SFP due to a break in a line or failure of a pump to stop. The connection for the SFP pumps' suction is located below normal water level and above the level needed to provide sufficient water for shielding and for cooling of the fuel if the SFPCS is unavailable. This design feature aids in minimizing the leakages and spills (dispersion of water) from the SFP.	9.1.2.2.2

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DCD_12.03-12.04-37

- Seismic loads (GDC 2)
- Flood, wind, ~~and~~ tornado and hurricane (GDC 2) DCD_02-03 S01
- Rain and snow (GDC 2)
- Pipe rupture (GDC 4)
- Codes and standards (GDC 1, "Quality Standards and Records")
- Containment integrity (GDC 16, "Containment Design")
- As-built reconciliation

14.3.4.3 ITAAC for Piping Systems and Components

Section 2.3 of Tier 1, which addresses piping systems and components, is prepared in accordance with the guidance in RG 1.206 (Reference 14.3-1), SRP 14.3 (Reference 14.3-2), and SRP 14.3.3 (Reference 14.3-7). The ITAAC in this section address piping system design and components, along with dynamic qualification, welding, fasteners, and safety classification of SSCs, covering matters such as the following:

- Piping design criteria, structural integrity, and functional capability of safety-related and risk-significant piping
- ASME Code Class 1, 2, and 3 piping and supports
- Buried piping and instrumentation lines
- Interaction of non-seismic piping with seismic Category I piping
- Any safety-related and risk-significant piping designed to industry standards other than the ASME Code
- Analysis methods, modeling techniques, pipe stress analysis criteria, pipe support design criteria, high-energy line break criteria, and the leak before break (LBB) approach, as applicable

Generic ITAAC – which apply to all ASME Class 1, 2, and 3 piping systems and high-energy and moderate-energy piping systems – provide for as follows: DCD_14.03.03-26

- ~~Requiring the existence of a design report to assure that the ASME Code Class 1 piping system and components are designed to retain their pressure boundary integrity and functional capability under internal design and operating pressures and design basis loads.~~
- Requiring the existence of a~~n ASME Code certified~~ stress report to assure that the ~~as-built~~ ASME Code Class 1, 2, and 3 piping systems and components are

- Post-TMI requirements such as power to the power-operated relief valves, block valves, and pressurizer heaters

Consistent with Appendix C.II.1-A of RG 1.206 (Reference 14.3-1), ITAAC entries for this equipment address (1) arrangement/configuration; (2) independence; (3) capacity and capability; (4) equipment protective features; (5) sensing instrumentation and logic; (6) controls, displays, and alarms; (7) test features; (8) connection of non-Class 1E loads on Class 1E busses; and (9) the location of equipment.

Based on the above criteria, the systems identified in Table 14.3-5 are selected as electrical systems in Tier 1.

14.3.4.7 ITAAC for Plant Systems

Section 2.7 of Tier 1, which addresses plant systems, is prepared in accordance with the guidance in RG 1.206 (Reference 14.3-1), SRP 14.3 (Reference 14.3-2), and SRP 14.3.7 (Reference 14.3-11). As indicated in Table 14.3-6, plant systems comprise most of the fluid systems that are not part of the reactor systems, including power generation systems; air systems; cooling water systems; radioactive waste systems; and HVAC systems, along with auxiliary systems, fire protection systems, and fuel handling systems. ITAAC are specified for these systems to provide for, as applicable:

- As-built plant reports for reconciliation with flood analyses to assure consistency with design requirements of SSCs for flood protection and mitigation
- As-built plant reports for reconciliation with post-fire safe shutdown analyses to assure consistency with design requirements of SSCs for fire protection and mitigation
- Verifying heat removal capabilities for design-basis accidents as well as tornado, hurricane and missile protection DCD_02-03 S01
- Verifying net positive suction head for key pumps
- Verifying physical separation for appropriate systems
- Verifying that the minimum inventory of alarms, controls, and indications – as derived from emergency procedure guidelines; RG 1.97(Reference 14.3-31); and PRA insights – is provided for the MCR and remote shutdown stations
- Commensurate with the importance of the design attribute to safety, verifying the following design attributes for plant systems:
    - Functional arrangement
    - Key design features of systems
    - Seismic and ASME code classifications
    - Weld quality and pressure boundary integrity, as necessary

BASES

LCO 3.0.9 (continued)

Barriers are doors, walls, floor plugs, curbs, hatches, installed structures or components, or other devices, not explicitly described in Technical Specifications, that support the performance of the safety function of systems described in the Technical Specifications. This LCO states that the supported system is not considered to be inoperable solely due to required barriers not capable of performing their related support function(s) under the described conditions. LCO 3.0.9 allows 30 days before declaring the supported system(s) inoperable and the LCO(s) associated with the supported system(s) not met. A maximum time is placed on each use of this allowance to ensure that as required barriers are found or are otherwise made unavailable, they are restored. However, the allowable duration may be less than the specified maximum time based on the risk assessment.

If the allowed time expires and the barriers are unable to perform their related support function(s), the supported system's LCO(s) must be declared not met and the Conditions and Required Actions entered in accordance with LCO 3.0.2.

This provision does not apply to barriers which support ventilation systems or to fire barriers. The Technical Specifications for ventilation systems provide specific Conditions for inoperable barriers. Fire barriers are addressed by other regulatory requirements and associated plant programs. This provision does not apply to barriers which are not required to support system OPERABILITY (see NRC Regulatory Issue Summary 2001-09, "Control of Hazard Barriers," dated April 2, 2001).

The provisions of LCO 3.0.9 are justified because of the low risk associated with required barriers not being capable of performing their related support function. This provision is based on consideration of the following initiating event categories:

------------------------------------ Reviewer's Note ----------------------------------
LCO 3.0.9 may be expanded to other initiating event categories provided plant-specific analysis demonstrates that the frequency of the additional initiating events is bounded by the generic analysis or if plant-specific approval is obtained from the NRC.

- Loss of coolant accidents;
- High energy line breaks;
- Feedwater line breaks;
- Internal flooding;
- External flooding;
- Turbine missile ejection; and
- Tornado, hurricane or high wind. DCD_02-03 S01

BASES

LCO 3.0.9 (continued)

The risk impact of the barriers which cannot perform their related support function(s) must be addressed pursuant to the risk assessment and management provision of the Maintenance Rule, 10 CFR 50.65 (a)(4), and the associated implementation guidance, Regulatory Guide 1.182, "Assessing and Managing Risk Before Maintenance Activities at Nuclear Power Plants." Regulatory Guide 1.182 endorses the guidance in Section 11 of NUMARC 93-01, "Industry Guideline for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants." This guidance provides for the consideration of dynamic plant configuration issues, emergent conditions, and other aspects pertinent to plant operation with the barriers unable to perform their related support function(s). These considerations may result in risk management and other compensatory actions being required during the period that barriers are unable to perform their related support function(s).

LCO 3.0.9 may be applied to one or more trains or subsystems of a system supported by barriers that cannot provide their related support function(s), provided that risk is assessed and managed (including consideration of the effects on Large Early Release and from external events). If applied concurrently to more than one train or subsystem of a multiple train or subsystem supported system, the barriers supporting each of these trains or subsystems must provide their related support function(s) for different categories of initiating events. For example, LCO 3.0.9 may be applied for up to 30 days for more than one train of a multiple train supported system if the affected barrier for one train protects against internal flooding and the affected barrier for the other train protects against tornado missiles and hurricane missiles. In this example, the affected barrier may be the same physical barrier but serve different protection functions for each train. DCD_02-03 S01

If during the time that LCO 3.0.9 is being used, the required OPERABLE train or subsystem becomes inoperable, it must be restored to OPERABLE status within 24 hours. Otherwise, the train(s) or subsystem(s) supported by barriers that cannot perform their related support function(s) must be declared inoperable and the associated LCOs declared not met. This 24 hour period provides time to respond to emergent conditions that would otherwise likely lead to entry into LCO 3.0.3 and a rapid plant shutdown, which is not justified given the low probability of an initiating event which would require the barrier(s) not capable of performing their related support function(s). During this 24 hour period, the plant risk associated with the existing conditions is assessed and managed in accordance with 10 CFR 50.65(a)(4).

vulnerabilities, and demonstrates seismic margins beyond the design-level safe-shutdown earthquake (SSE). DCD_19-564

Other external events (high winds, ~~and~~ tornadoes, hurricanes, external floods, transportation accidents, nearby facility accidents, and aircraft crashes) are subject to screening criteria consistent with ASME/ANS RA-S-2008 and associated addenda. DCD_02-03 S01

The Level 2 PRA results in LRFs for internal events at full power and the evaluation involves the following:

- Plant damage state (PDS) analysis
- Accident progression analysis
- Quantification

The primary guidance for this analysis is ASME/ANS RA-S-2008 and addenda, NUREG/CR-2300, and RG 1.200 (Reference 19.1-4, 19.1-9, 19.1-49, 19.1-50). MAAP version 4.0.6 (Reference 19.1-10) is employed to evaluate severe accident phenomena.

The Level 2 evaluation of the flooding and fire external events at full-power conditions is based on the same approach as for internal events. Fault trees are modified to take into account flood/fire induced failures of severe accident mitigation features and these fault trees are mapped into the internal events through the associated PDSs.

For events at LPSD, the LRFs are conservatively assumed to be the same as the core damage frequencies, with a simple bounding technique.

19.1.1 Uses and Applications of the PRA

19.1.1.1 Design Phase

The design-specific US-APWR PRA is an integral part of the design process and has been used to optimize the plant design with respect to safety. The PRA models and results have influenced the selection of design alternatives such as four train core cooling systems, an in-containment refueling water storage pit (RWSP), and full digital instrumentation and control (I&C) systems. DCD_19-564

The US-APWR is expected to perform better than current operating plants in the area of severe accident performance since prevention and mitigation of severe accidents have been addressed during the design stage, taking advantage of PRA results and severe accident analysis. The PRA results indicate that the US-APWR design results in a low level of risk and meets the CDF, LRF, and containment performance goals for new generation pressurized water reactors (PWRs).

At the design phase, the design-specific PRA results have been used as information providing input to technical specifications (Chapter 16), RAP (Chapter 17, Section 17.4), the security plan, and other design areas. ~~PRA insights are utilized to develop risk-managed technical specifications (RMTS) and surveillance frequency control program (SFCP) in accordance with Reference 19.1-11 and 19.1-44, respectively.~~ PRA was used to determine the components and instruments that would be subjected to ~~RMTS and~~ DCD_19-564 DCD_19-564

~~SFCP~~risk managed technical specifications (RMTS) and surveillance frequency control program (SFCP). DCD_19-564

Information regarding loss-of-coolant accident (LOCA) scenarios followed by failures of accumulators and the risk impact of accumulator unavailability were used to confirm the applicability of standard technical specification requirements to the US-APWR design so the applicability of standard technical specification were considered applicable to the US-APWR design.

Sensitivity analysis results regarding reliability of the protection and safety monitoring system (PSMS) were used to confirm the completion time and surveillance frequencies in the US-APWR technical specification are sufficient not to degrade plant safety. Sensitivity analysis results showed that the changes from the standard technical specification, increases in surveillance frequencies, would not result in significant increase in risk.

19.1.1.2 Combined License Application Phase

19.1.1.2.1 Uses of Probabilistic Risk Assessment in Support of Licensee Programs

~~The~~A site-specific PRA in the Combined License Application (COLA) phase will be used to support licensee programs such as the human factors engineering program (Chapter 18) and the severe accident management program. The PRA in the COLA phase will also be utilized to support implementation of 10 CFR 50.65 (Reference 19.1-12), the maintenance rule, and the technical specification as well as the reactor oversight process including the mitigating systems performance index and the significance determination process. DCD_19-564

The PRA may require updating to assess site-specific information (e.g., ultimate heat sink) and associated site-specific external events (high winds, ~~and~~ tornadoes, hurricanes, external floods, transportation, and nearby facility accidents). DCD_02-03 S01

19.1.1.2.2 Risk-Informed Applications

~~As discussed in Subsection 19.1.1.1,~~Site-specific PRA insights are utilized to develop ~~site-specific~~ risk-managed technical specifications~~, RAP, and other risk informed applications~~ if the COL applicant chooses to adapt risk-managed technical specifications. DCD_19-564

19.1.1.3 Construction Phase

~~The~~A site-specific PRA may require updating during the construction phase to reflect site-specific characteristics or design changes. The PRA may also be used to support licensee programs or risk-informed applications as appropriate. DCD_19-564

19.1.1.3.1 Uses of Probabilistic Risk Assessment in Support of Licensee Programs

The PRA in the construction phase will be used to support licensee programs such as the human factors engineering program (Chapter 18) and the severe accident management program.

19.1.5 Safety Insights from the External Events PRA for Operations at Power

External events considered in the US-APWR PRA are those whose cause is external to all systems associated with normal and emergency operations situations, with the exception of internal fires and floods, which are included here based on historical protocol. Some external events may not pose a significant threat of a severe accident. Some external events are considered at the design stage and have a sufficiently low contribution to CDF or plant risk. Chapter 2 of the COLA Final Safety Analysis Report (FSAR) will provide information concerning the geological, seismological, hydrological, environmental, and meteorological characteristics of the site and vicinity, in conjunction with present and projected population distribution, including land use relative to site activities and controls. Chapter 2 of the COLA FSAR will contain site specific information as compared to the standard design envelope criteria. Assessing the risk of external events necessarily includes site-specific issues. Chapter 2 of the DCD contains generic site parameter requirements necessary to meet the engineering and design needs for safe construction and operation of the US-APWR. Based primarily upon the guidelines provided in Generic Letter 88-20 (Reference 19.1-33) and ANSI/ANS-58.21-2007 (Reference 19.1-8), the following is a list of external events that are included for US-APWR analysis.

1. High winds, ~~and~~ tornadoes and hurricanes DCD_02-03 S01
2. External flooding
3. Transportation and nearby facility accidents
4. Aircraft crash
5. Seismic
6. Internal fires
7. Internal flooding

The last three events listed above receive detailed evaluation in the following subsection. The first four cannot be properly evaluated until a specific site has been selected. Chapter 2 of this DCD contains bounding site parameter requirements for following events.

- Nearby industrial, transportation, and military facilities
- Meteorology
- Hydrologic engineering
- Geology, seismology, and geotechnical engineering

Evaluation of potential accidents for the nearby industrial, transportation, and military facilities in Chapter2 is a probabilistic and predictive approach that will be followed and documented in the COLA to verify that a 10^{-7} per year occurrence rate has been demonstrated. For low probability events, where data may not be available, a 10^{-6} per