9.1 FUEL STORAGE AND HANDLING

Facilities for the receipt and storage of new fuel and the storage and transfer of spent fuel are housed in the Fuel Handling Building (FHB). A separate and independent FHB is provided for each unit of the South Texas Project Electric Generating Station (STPEGS). Each FHB is designed as a controlled-leakage seismic Category I structure. The design of the FHB Heating, Ventilating and Air-Conditioning (HVAC) System is discussed in Section 9.4.2. The structural design considerations are described in Section 3.8.4.

9.1.1 New Fuel Storage

9.1.1.1 Design Bases. The new fuel storage pit is a reinforced concrete pit and an integral part of each seismic Category I FHB. This pit provides temporary dry storage for approximately one-third of a core (66 fuel assemblies) of new fuel. The fuel is stored in racks (Figure 9.1.1-1) composed of individual vertical cells fastened together to form three 2 x 11 modules which may be bolted to anchors in the floor and walls of the new fuel storage pit. The new fuel racks are classified as seismic Category I components, as defined by Regulatory Guide (RG) l.29, and American Nuclear Society (ANS) safety class (SC) 3 (Section 3.2).

The new fuel racks are designed with a center-to-center spacing of 2l inches. This spacing provides a minimum of l2 in. between adjacent fuel assemblies. This separation is sufficient to maintain a subcritical array assuming optimum moderation. Space between storage positions is blocked to prevent insertion of fuel. All rack surfaces that come into contact with the fuel assemblies are made of annealed authentic stainless steel, and the support structure is painted carbon steel.

The racks are designed to withstand normal operating loads, as well as to remain functional with the occurrence of a Safe Shutdown Earthquake (SSE). The new fuel racks are designed to withstand a maximum uplift force of 5,000 pounds and to meet the requirements of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (B&PV) Code, Section III, Appendix XVII.

The new fuel storage pit access hatch is a three-section cover. This cover will minimize the introduction of dust and debris into the pit. The cover is designed to withstand the impact force of a new fuel assembly dropped from the maximum elevation allowed by the 2-ton hoist of the FHB overhead crane.

In addition, space is provided for the storage of fuel during refueling inside the Reactor Containment Building (RCB). See Section 9.1.2.1 for a description of the racks.

9.1.1.2 Facilities Description. The FHB abuts the south side of the RCB and is adjacent to the west side of the Mechanical-Electrical Auxiliaries Building (MEAB) of each unit. The locations of the two FHBs are shown in the station plot plan on Figure l.2-3. For the general arrangement drawings of the new fuel storage facilities, refer to Figures l.2-39 through l.2-48 as listed in Table 1.2-1.

New fuel assemblies are received in the receiving area of each FHB and temporarily stored in the shipping containers in the new fuel inspection laydown area.

In the new fuel inspection laydown area, each new fuel assembly is removed from its shipping container and inspected visually to confirm the assembly has not been damaged during shipment.

The new fuel assemblies are transported to the new fuel storage pit or to the new fuel elevator by the l5/2-ton, dual-service FHB crane. The 2-ton hoist of this crane is designed to handle new fuel assemblies. New fuel handling is discussed in detail in Section 9.1.4. Use of the 2-ton hoist of the l5/2-ton crane or of the fuel-handling machine to handle new fuel ensures that the design uplift of the racks will not be exceeded.

The new fuel storage pit is situated in the approximate center of each FHB. The floor of the new fuel storage pit is at El. 50 ft-3 inches. The new fuel storage pit access hatch is provided with a three-section protective cover at El. 68 ft. The fuel assemblies are loaded into the new fuel storage racks through the top and stored vertically.

9.1.1.3 <u>Safety Evaluation</u>. Units l and 2 of the STPEGS are each provided with separate and independent fuel handling facilities.

Flood protection of each FHB is discussed in Section 3.4.1. Flooding of the new fuel storage pit from fluid sources inside either FHB is not considered credible since all fluid systems components are located well below the elevation of the new fuel storage pit access hatch. A floor drain is provided in the new fuel storage pit to minimize collection of water.

The applicable design codes and the ability of the FHB to withstand various external loads and forces are discussed in Section 3.8.4. Details of the seismic design and testing are presented in Section 3.7. Missile protection of the FHBs is discussed in Section 3.5. Failure of nonseismic systems or structures will not decrease the degree of subcriticality provided in the new fuel storage pit.

In accordance with American National Standards Institute (ANSI) N18.2, the design of the normally dry new fuel storage racks is such that the effective multiplication factor will not exceed 0.98 with fuel of the highest anticipated enrichment in place, assuming optimum moderation (under dry or fogged conditions). For the unborated flooded condition, assuming new fuel of the highest anticipated enrichment in place, the effective multiplication factor does not exceed 0.95. Credit may be taken for the inherent neutron-absorbing effect of the materials of construction.

The new fuel assemblies are stored dry, the 21-in. spacing ensuring a safe geometric array. Under these conditions, a criticality accident during refueling and storage is not considered credible. Consideration of criticality safety analysis is discussed in Section 4.3.

Design of the facility in accordance with RG l.13 ensures adequate safety under both normal and postulated accident conditions. The new fuel storage racks also meet the requirements of General Design Criterion (GDC) 62.

9.1.2 Spent Fuel Storage

9.1.2.1 <u>Design Bases</u>. The spent fuel pool (SFP) is a stainless steel-lined reinforced concrete pool and is an integral part of each FHB. All spent fuel racks are classified as seismic Category I, as defined by RG l.29, and as ANS SC 3.

The spent fuel storage facility provides storage capacity for 1,969 high density absorber spent fuel racks in a honeycomb array in each unit. Two storage regions are provided in the SFP. Figure 9.1.2- CN-3086

2 shows the pool layout for both Units 1 and 2. The six Region 1 rack modules are located in the northwest corner of the spent fuel pool.

The Region 1 racks have 10.95-in. nominal center-to-center spacing between the cells. This region is conservatively designed to accommodate unirradiated fuel at enrichments to 4.95 weight percent. Region 1 storage cells are each bounded on four sides by a water box except on the periphery of the pool. The Region 1 spent fuel racks include a lead-in-guide to assist in depositing fuel assemblies into the fuel cell. Figure 9.1.2-3 shows a typical Region 1 spent fuel rack.

The reactivity characteristics of fuel assemblies which are to be placed in the spent fuel storage racks are determined and the assemblies are categorized by reactivity. Alternately, if necessary, all assemblies may be treated as if each assembly is of the highest reactivity class until the actual assembly reactivity classification is determined. Section 5.6 of the Technical Specifications provides the definitions of the reactivity classifications and the allowed storage patterns. Fuel assemblies are loaded into the racks in a geometrically safe configuration to ensure rack subcriticality.

Fuel assembly reactivity requirements for close packed storage and checkerboard storage are specified in the Technical Specifications. The boron concentration of the water in the spent fuel pool is maintained at or above the minimum value needed to ensure that the rack K_{eff} is less than or equal to 0.95 in the event of misplaced assemblies in the close packed storage areas or in checkerboard storage areas. Consideration of criticality safety is discussed in Section 4.3.

The Region 2 racks have a 9.15-in. nominal center-to-center spacing with fixed absorber material surrounding each cell. A sheet of neutron absorber material is captured between the side walls of all adjacent boxes. To provide space for the absorber sheet between boxes, a double row of matching flat round raised areas are coined into the side walls of all boxes. The raised dimension of these locally formed areas on each box wall is half the thickness of the absorber sheet. The boxes are fusion welded together at all these local areas. The absorber sheets are scalloped along their edges to clear these areas. Figure 9.1.2-4 shows a typical Region 2 spent fuel rack.

The axial location of the absorber with respect to the active fuel region is provided and maintained by the structure of each box. At the outside periphery of each rack, a sheet of absorber material is captured under thin stainless sheets which are intermittently welded all around to the box.

All rack surfaces that come into contact with fuel assemblies are made of annealed austenitic stainless steel. These materials are resistant to corrosion during normal and emergency water quality conditions. The racks are designed to withstand normal operating loads as well as to remain functional with the occurrence of an SSE. The racks are designed with adequate energy absorption capabilities to withstand the impact of a dropped spent fuel assembly from the maximum lift height of the spent fuel pit bridge hoist. The racks are designed to withstand a maximum uplift force equal to the uplift force of the bridge hoist. The 14-in. and 16-in. racks also meet the requirements of ASME Code, Section III, Appendix XVII. The high-density spent fuel racks meet the criteria of Appendix D to Standard Review Plan (SRP) 3.8.4.

Shielding for the SFP is adequate to protect plant personnel from exposure to radiation in excess of published guideline values as stated in Section l2.1. A minimum depth of approximately 13 ft of water over the top of an array of 193 (full core) assemblies with 42 hours of decay is required to limit radiation from the assemblies to 2.5 mR/hr. or less.

The FHB Ventilation Exhaust System is designed to limit the offsite dose in the event of a significant release of radioactivity from the fuel, as discussed in Sections l2.3.3, l5.7.4, and 9.4.2. However, no credit for the FHB Ventilation Exhaust System is taken in the LOCA and Fuel Handling accident in Chapter 15.

The FHB is designed to prevent missiles from contacting the fuel. A more detailed discussion on missile protection is given in Section 3.5.

In addition, space is provided for storage of fuel during refueling inside the RCB for 64 fuel assemblies in four 4 x 4 modules having 16-in. center-to-center spacing (Figure 9.1.2-1A). These modules are firmly bolted in the floor.

9.1.2.2 Facilities Description. The FHB abuts the south side of the RCB and is adjacent to the west side of the MEAB of each unit. The locations of the two FHBs are shown in the station plot plan on Figure l.2-3. For general arrangement drawings of the spent fuel storage facilities, refer to Figures l.2-39 through l.2-48 as listed in Table 1.2-1.

The spent fuel storage facilities are designed for the underwater storage of spent fuel assemblies and control rods after their removal from the reactor vessel. The spent fuel is transferred to the FHB and handled and stored in the spent fuel pool underwater. The fuel is stored to permit some decay, then transferred offsite. For a detailed discussion of spent fuel handling, see Section 9.1.4.

The SFP is located in the northwest quadrant of each FHB. The floor of the pool is at El. 2l ft-11 in., with normal water level at El. 66 ft-6 inches. The top of a fuel assembly in a storage rack does not extend above the top of the storage rack which is El. 39 ft-10 in. maximum. The fuel assemblies are loaded into the spent fuel racks through the top and are stored vertically.

9.1.2.3 Safety Evaluation. Units l and 2 of the STPEGS are each provided with separate and independent fuel handling facilities. Flood protection of each FHB is discussed in Section 3.4.1. A detailed discussion of missile protection is provided in Section 3.5.

The applicable design codes and the various external loads and forces considered in the design of the FHB are discussed in Section 3.8.4. Details of the seismic design and testing are presented in Section 3.7.

Design of this storage facility in accordance with GDC 62 and RG 1.13 ensures a safe condition under normal and postulated accident conditions. The K_{eff} of the spent fuel storage racks is maintained less than or equal to 1.00, even if unborated water is used to fill the spent fuel storage pool, by both the designs of the fuel assemblies and the storage rack and the use of administrative procedures to control the placement of burned and fresh fuel and control rods.

Under accident conditions, the K_{eff} is maintained well below 0.95 assuming 2200 ppm borated water. The boron concentration of the water in the spent fuel pool is maintained at or above the minimum value needed to ensure that the rack K_{eff} is less than or equal to 0.95 in the event of a single misplaced assembly. Consideration of criticality safety is discussed in Section 4.3.

The SFP is designed to maintain leaktight integrity. To ensure such integrity, the pool is lined with stainless steel plate, and plate welds are backed with channels to detect and locate leakage. Leakage entering these channels is directed to the Liquid Waste Processing System (LWPS) via the FHB sump. Should a leak be detected, either by a low-level alarm (setpoint: 6 in. below normal water level) or by the fuel pool liner channel leak detection method, the operator would initiate makeup to the spent fuel pool. Makeup capability is provided by permanently installed connections to: (l) the Demineralized Water System (DWS), (2) the Reactor Makeup Water System (RMWS), and (3) the refueling water storage tank (RWST) in the Emergency Core Cooling System (ECCS).

A complete loss of SFP cooling is not considered a credible event since the components involved are designed to SC 3 seismic Category I requirements and could be powered from redundant Engineered Safety Features (ESF) power supplies. Further, the systems providing cooling are redundant. Therefore, no single failure would result in a complete loss of fuel pool cooling. For a more detailed discussion of SFP cooling, refer to Section 9.1.3.

9.1.3 Spent Fuel Pool Cooling and Cleanup System

The Spent Fuel Pool Cooling and Cleanup System (SFPCCS) is designed to remove the decay heat generated by spent fuel assemblies stored in the SFP and/or the in-Containment storage area. A second function of the system is to maintain visual clarity and purity of the spent fuel cooling water and the refueling water.

9.1.3.1 Design Bases. The SFPCCS design heat loads are given in Table 9.1-1. These heat loads and associated maximum spent fuel pool water temperatures are based on assumptions identified in the Standard Review Plan for a typical 12-month fuel cycle. Section 9.1.3.2.2 describes how these spent fuel pool water temperatures are maintained during actual refueling operations at STP. The maximum spent fuel pool water temperature of 150.7°F for the Normal Maximum case with 1 cooling train is not exceeded, regardless of fuel cycle length. System capabilities to withstand natural phenomena and piping rupture are addressed in Chapter 3. The spent fuel pool cooling portions of the SFPCCS are designed to seismic Category I requirements, and are located in the FHB, a seismic Category I building. The spent fuel pool water purification portions of the SFPCCS are not required for safety functions and are not designed to seismic Category I requirements.

9.1.3.1.1 Spent Fuel Cooling: The SFPCCS is designed to remove the amount of decay heat produced by the number of spent fuel assemblies that are stored following refueling. The system design incorporates two trains of equipment. Each train is capable of removing 100 percent of the normal maximum design heat load and 50 percent of the abnormal maximum design heat load. The system can maintain the spent fuel cooling water temperature at or below the maximum allowable temperatures specified by Table 9.1-1 as discussed in Section 9.1.3.2.2. This temperature is based on the heat exchangers (HXs) being supplied with component cooling water (CCW) at the design flow and temperature. The flow through the spent fuel storage areas provides sufficient mixing to maintain uniform water conditions.

If it is necessary to remove a complete core from the reactor, the system can maintain the spent fuel cooling water below the maximum allowable temperature specified by Table 9.1-1. Makeup water requirements will be provided by either reactor makeup water, demineralized water, or refueling water. The makeup flowpath from the reactor makeup water storage tank (RMWST) is seismic Category I. The flowpaths from the demineralized water storage tank (DWST) and from the RWST are nonseismic Category I.

9.1.3.1.2 Dewatering Protection: A minimum depth of approximately 13 ft of water over the top of an array of 193 (full core) assemblies with 42 hours of decay is required to limit radiation from the assemblies to 2.5 mR/hr. or less. System piping is arranged so that failure of any pipeline cannot drain the spent fuel pool or the in-Containment temporary storage area below a depth of approximately 23 ft of water over the top of the stored spent fuel assemblies. Additionally, means are provided to detect component or system leakage. Refer to Section 9.3.3 for the detailed description of leak detection via the floor drains. In addition, the water level instrumentation provides a means of leakage detection.

9.1.3.1.3 Water Purification: The system's demineralizers and filters are designed to provide adequate purification to permit unrestricted access for plant personnel to spent fuel storage areas and to maintain optical clarity of the spent fuel cooling water and the refueling water. The optical clarity of the spent fuel pool surface is maintained by use of the system's skimmer pump, skimmer/suction head assemblies, and skimmer filter. The optical clarity of the spent fuel pool and the refueling cavity water is maintained by use of temporary portable filters. The Nuclear Steam Supply System (NSSS) vendor-recommended specifications and guidelines for the spent fuel pool water purity are provided in Table 9.1-4 and the monitoring frequency is provided in Table 9.3-3.

9.1.3.2 System Description. The SFPCCS, shown on Figures 9.1.3-1 and 9.1.3-2 (piping and instrumentation diagrams [P&IDs]), consists of two cooling trains, two purification trains, and a surface skimmer loop.

The SFPCCS removes decay heat produced by spent fuel after it is removed from the reactor. Spent fuel is removed from the reactor core during the refueling sequence and placed in the SFP, where it is stored until it is shipped offsite for reprocessing or permanent storage. If, for some reason, it is desirable or necessary to delay the transfer of the spent fuel to the SFP, the in-Containment storage area can be used for temporary storage of up to one-third of a core. The system normally handles the heat load from one core region freshly discharged from the reactor. Heat is transferred from the SFPCCS through the HXs to the Component Cooling Water System (CCWS).

When the SFPCCS is in operation, water drawn from the SFP (and/or from the in-Containment storage area) by the SFP pumps is pumped through the tube side of the HXs, and then is returned to the spent fuel pool (and/or the in-Containment storage area). Each suction connection, which is provided with a strainer, is located at an elevation 4 ft below the normal water level (approximately 23 ft above the top of the fuel assemblies). The return line contains an antisiphon hole near the surface of the water to prevent gravity drainage.

To maintain spent fuel cooling water purity, a bypass circuit composed of a demineralizer and a filter is connected to each cooling train. The demineralizers are charged with either a mixed resin (cation and anion resin) or cation resin only, dependant on the type of contamination indicated by the required chemical analyses. While the heat removal operation is in process, a portion of the spent fuel cooling water is diverted upstream of each HX and passed through the purification circuit, returning downstream of the HXs. The demineralizers remove ionic corrosion impurities and fission products. Filters are provided to remove any additional particulates and to prevent any resin fines from entering the system from the demineralizer discharge. Transfer canal water may be circulated through the same purification circuits by removing the gate between the canal and the spent fuel pool. These purification loops are sufficient for removing fission products and other contaminants which may be introduced into the spent fuel cooling water.

One purification loop may be isolated from the heat removal portion of the SFPCCS. By so doing, the isolated equipment may be used in conjunction with either the reactor coolant drain tank pumps or the refueling water purification pump to clean and purify the refueling water while spent fuel cooling and spent fuel cooling water cleanup operations proceed. Connections are provided such that the refueling water may be pumped from either the RWST or the refueling cavity through the demineralizer and filter, and discharged to either the refueling cavity or the RWST. Samples are periodically taken to determine the need for purification of the water as well as the purification efficiency.

To further assist in maintaining spent fuel cooling water clarity, the spent fuel pool is cleaned by a skimmer loop. Water is removed from the surfaces via two skimmer/suction head assemblies located in the SFP. Water is pumped through a filter by a skimmer pump and returned to the pool surface at a single location remote from the skimmer/suction head assemblies. Piping for future addition of a third skimmer/suction head for cleaning the surface of the fuel transfer canal water is also provided.

The SFP is initially filled with water having the same boron concentration as that in the RWST. Borated water may be supplied from the RWST via the SFPCCS return header, or by running a temporary line from the boric acid blending tee, located in the Chemical and Volume Control System (CVCS), directly into the pool. Demineralized water can also be added for makeup purposes (i.e., to replace evaporative losses) through a connection in the SFPCCS return header. The water in the spent fuel pool may be separated from the water in the transfer canal by a gate. The gate is installed so that the transfer canal may be drained. The water is removed from the canal using a pump. When the activities requiring drain down are complete, the canal is refilled and borated prior to removal of the gate.

When spent fuel assemblies are stored in the in-Containment storage area, either of the cooling trains may be utilized to remove the decay heat. The in-Containment storage area is sized to temporarily store one-third of a core.

The in Containment storage area is directly connected to the refueling cavity and is filled with refueling water whenever the refueling cavity is filled. Thus, during refueling, the in Containment storage area is always ready for use. During refueling outages, the clarity of the water in the reactor cavity is maintained by use of temporary portable filters.

9.1.3.2.1 Component Description: The design codes and classifications of the components are given in Section 3.2. Equipment design parameters are given in Table 9.1-2.

Spent Fuel Pool Pumps

The pumps are horizontal, centrifugal units, with all wetted surfaces being stainless steel. The pumps draw water from the spent fuel pool (and/or the in-Containment storage area) and deliver it to the HXs for cooling and to the purification trains for cleanup.

Spent Fuel Pool Skimmer Pump

This horizontal, centrifugal pump takes suction from the SFP via adjustable surface skimmer/suction head assemblies and from the fuel transfer canal and circulates the water through a filter and returns it to the SFP and the fuel transfer canal. All wetted surfaces of the pump are austenitic stainless steel.

Refueling Water Purification Pump

This centrifugal pump is used to circulate water from the RWST through a SFP demineralizer and filter.

Spent Fuel Pool Heat Exchangers

The HXs are the shell and U-tube type. Spent fuel cooling water circulates through the tubes while CCW circulates through the shell. Each HX is sized for 50 percent of the heat load. The design heat load of the SFP HXs is based on the decay heat generated by one-third of a core placed in the SFP shortly after reactor shutdown during a refueling operation with one-third of a core from the previous refueling already in the pool.

Spent Fuel Pool Demineralizers

The two flushable demineralizers are designed to provide adequate spent fuel cooling water purity for unrestricted access of plant personnel to the spent fuel storage areas.

Spent Fuel Pool Filters

A filter is located in each purification train, downstream of the demineralizer, to collect possible particulates and resin fines passed by the demineralizer. The filter assembly utilizes a disposable cartridge filter and is readily accessible for filter change.

Spent Fuel Pool Skimmer Filter

The SFP skimmer filter is used to remove particles swept from the spent fuel pool surface. The filter assembly utilizes a disposable cartridge filter and is readily accessible for filter change.

Spent Fuel Pool Strainers

A strainer is located in each SFP pump suction line from the SFP to prevent introduction of relatively large particles that might clog the spent fuel demineralizers or damage the SFP pumps.

Spent Fuel Pool Skimmer/Suction Head Assemblies

Two assemblies are provided. These assemblies make it possible to take suction from the pool surface.

Fuel Transfer Canal Skimmer/Suction Head Assembly (Future Expansion)

Piping is provided for future addition of one assembly which would take suction from the transfer canal surface. Debris would be removed via the skimmer filter.

In-Containment Storage Area Strainer

A strainer is located in the SFP pump suction line from the in-Containment storage area to prevent introduction of relatively large particles that might clog the SFP demineralizers or damage the SFP pumps.

9.1.3.2.2 Spent Fuel Pool Cooling During Refueling Operations: During refueling operations, either a full core offload or fuel shuffle is considered routine practice. During full core offload conditions at STP, to provide protection against single failure, the backup train of SFP cooling is administratively required to be either available or able to be restored to service within an analyzed time frame consistent with the time required to reach licensing basis temperature limits. At least one SFP cooling train will be available at all times backed by an on-site power source. When required, the second cooling train will at least be functional, backed by either an on-site power source or a power source available from the switchyard.

Table 9.1-1 gives the maximum calculated SFP water temperatures for various fuel load and SFP cooling configurations. These heat loads and associated temperature limits are based on assumptions identified in the Standard Review Plan for a typical 12-month fuel cycle. However, STP typically operates at 18-month fuel cycles, therefore these temperature limits apply to any cycle length. For either full-core offloads or fuel shuffles, the maximum pool temperature of 150.7°F will not be exceeded during normal refueling operations, regardless of fuel cycle length.

Cycle specific calculations are typically performed prior to fuel offload to ensure the maximum SFP water temperature will not exceed 150.7°F and that the heat load used in SFP boiling dose analysis remains bounding. In addition, the SFP TROUBLE alarm is set to ensure that the maximum SFP water temperature is not exceeded in the event of a failure of a SFP cooling train.

9.1.3.3 Safety Evaluation.

9.1.3.3.1 Availability and Reliability: The SFPCCS has no emergency function during an accident except to provide adequate cooling to the SFP. Since it is not necessary for automatic initiation post-accident, the SFP pumps are manually placed on the emergency power bus after completion of automatic load sequencing. In the event of failure of a SFP pump or loss of cooling to a SFP HX, the second cooling train would provide continued cooling of the stored spent fuel with the spent fuel cooling water at a higher equilibrium temperature (Table 9.1-1). A failure modes and effects analysis for the SFPCCS is given in Table 9.1-5.

9.1.3.3.2 Spent Fuel Storage Area Dewatering:The most serious failure of this system would be complete loss of water in one of the storage areas. To protect against that possibility, the SFP pump suction connections enter near the normal water level so that the storage areas cannot be siphoned. The cooling water return line to each storage area contains an antisiphon hole to prevent the possibility of siphoning. These design features assure that neither the SFP nor the in-Containment storage area can be drained more than 4 ft below the normal water level (normal water level is approximately 27 ft above the top of the stored spent fuel).

If a seismic event results in the failure of a non-seismic pipe in the reactor makeup water tank compartment, both reactor makeup pumps may be lost because of flooding in this compartment. As a result, makeup for the SFP from the RMWS would be lost. However, the following means may still be available to provide makeup to the SFP.

1. Water from the RWST (seismic Category I) through the nonseismic Category I refueling water purification pump 1A and SFP demineralizer 1A to the SFP cooling return line.

2. Demineralized water through a 2-in. line connecting the demineralized water system to the SFP cooling return line.

3. Fire water from either one or both of the hose reel and hose cabinet located near the SFP.

In the unlikely event that all of these backup sources were not available, a seismically qualified makeup water source would be provided by connecting temporary hoses to the vent and drain valves located on the low head safety injection (LHSI) pump discharge piping. The LHSI pumps are located in the FHB at the lowest level. The hoses will be routed through building stairways and equipment hatches to the SFP. Assuming a complete loss of SFP cooling and a heat load as described in 9.1.3.3.4 below, the heatup time to boiling is approximately 8 hours based upon a water loss equivalent to 4 ft of pool level. This allows sufficient time to route the hoses through the building.

9.1.3.3.3 Water Quality: Whenever a fuel assembly with defective cladding is removed from the reactor core, a small quantity of fission products may enter the spent fuel cooling water. The purification loops provide a means of removing fission products and other contaminants from the water. By maintaining radioactivity concentrations in the spent fuel cooling water at 5 x 10^{-3} μCi/cc (β and γ) or less, the dose at the water surface is 2.5 mR/hr or less.

9.1.3.3.4 Spent Fuel Pool Boiling Dose Analysis: In the event of a fire or moderate energy line crack in the FHB that disables both trains of SFP cooling, the SFP temperature would begin to rise and, assuming no corrective action, would eventually boil. The following analysis examines the dose consequences of a loss of the SFP cooling and the use of the seismic Category 1 makeup water source (RMWS). This analysis uses the TID-based source terms (Safety Guide 1.25).

It is assumed that a loss of the SFP cooling occurs after a core offload which generates a maximum decay heat of 9.5 x 10^7 Btu/hr. This is verified before the beginning of each core offload to Spent Fuel Pool. For the purpose of this analysis, the pool is conservatively assumed to boil instantaneously after the loss of the SFP cooling. This loss of SFP cooling is assumed to occur at 42 hours after shutdown. Throughout the event, the leakage rate for iodine is assumed to be the normal full power rate (1.3 x 10^{-8} sec^{-1}). The Iodine 131 available for release is based upon the gap activity containing 12 percent of the rod inventory and the leakage occurs from the defective 1 percent of the rods. The activity of the refueling water prior to initiation of the event is assumed to be negligible.

Using these assumptions and those found in Table 9.1-6, the thyroid dose consequences of releasing the iodine as a result of SFP boiling are well below the dose requirements of 10CFR, Part 100.

9.1.3.4 Instrumentation Application. The instrumentation provided for the SFPCCS is discussed below. Alarms and indications are provided as noted.

9.1.3.4.1 Temperature: Instrumentation is provided to measure the temperature of the water in the SFP and in the in-Containment storage area and to give local indication as well as annunciation at the main control board when normal temperatures are exceeded.

Instrumentation is also provided to give local indication of the temperature of the spent fuel cooling water as it leaves each HX.

9.1.3.4.2 Pressure: Instrumentation is provided to measure and give local indication of the pressures in the suction line of the SFP skimmer pump and in the suction and discharge lines of the refueling water purification pump and of each SFP pump. Instrumentation is also provided at locations upstream and downstream of each SFP filter, each SFP skimmer filter, and each of the SFP demineralizer so that the pressure differential across these filters can be determined.

9.1.3.4.3 Flow: Instrumentation is provided to measure and give local indication of the flow in the outlet line of each SFP filter. Instrumentation is also provided to measure discharge flow from the SFP pumps and the refueling water purification pump and to provide a low-flow alarm on the main control board in addition to providing local flow indication.

9.1.3.4.4 Level: Instrumentation is provided to give an alarm in the control room when the water level in the SFP or in the in-Containment storage area reaches either the high or low-level setpoints (6 in. above or below normal water level).

A two channel, non-safety related Spent Fuel pool level indicating system has been installed. Each channel provides a signal equivalent to the spent fuel pool level to its indicator located in the radwaste control room. The system meets NRC Executive Order EA-12-051 ″Issuance of Order to Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation" and Nuclear Energy Institute (NEI) guide 12-02 "Industry Guidance for Compliance with NRC Order EA-12-051, "To Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation"". CN-3155

9.1.3.5 Tests and Inspections. Active components of the SFPCCS are in either continuous or intermittent use during normal system operation. The SFPCCS is included in the inservice inspection requirements described in Section 6.6 and the inservice testing requirements described in Section 3.9.6.

9.1.4 Fuel Handling System

9.1.4.1 Design Bases. The FHS consists of equipment and structures utilized in the transporting and handling of the fuel from the time it reaches the station until it leaves the station.

The following design bases apply to the FHS:

1. Fuel-handling devices have provisions to avoid dropping or jamming of fuel assemblies during transfer operation.

2. Fuel lifting and handling equipment will not fail in such a manner as to damage seismic Category I equipment in the event of an SSE.

3. The Fuel Transfer System (FTS), where it penetrates the Containment, has provisions to preserve the integrity of the Containment pressure boundary, including a means to test for leak tightness.

4. Each machine used to lift spent fuel has a limited maximum lift height so that the minimum required depth of water shielding is maintained.

5. The cask handling components and the FHB layout limit vertical lift above the floor of the cask to less than 30 ft above the floor during any moving sequence.

6. The Spent Fuel Cask Handling System (SFCHS) utilizes a wet handling technique.

7. The pool gates are designed to maintain their integrity in the event of an SSE.

9.1.4.2 System Description. The equipment in the FHS is comprised of lifting equipment, handling equipment, an FTS, and the SFCHS. The structures associated with the FHS are the refueling cavity, refueling canal, and in-Containment fuel storage area inside the RCB; and the fuel transfer canal, SFP, new fuel storage pit and inspection area, and cask loading pool and decontamination platform in the FHB. The equipment is located in seismic Category I buildings.

9.1.4.2.1 New Fuel Handling: The new fuel arrives onsite by truck. The truck receiving area is located on the ground floor of the FHB. When new fuel is delivered to the receiving area within the FHB, the shipping containers are unloaded from the transport vehicle and examined for shipment damage. The shipping containers are lifted to the new fuel inspection laydown area on the operating floor by the FHB overhead crane. The shipping containers are placed horizontally on the floor. Next, for each shipping container, the container cover is removed and the pivotal, fuel support structure within the shipping container is elevated from the horizontal to the vertical position. In the new fuel inspection laydown area on the operating floor, this is accomplished using the FHB overhead crane. The various clamping devices securing the fuel assembly to the support structure are then removed. The fuel assembly is lifted from the shipping container support structure. Inspection activities may now be conducted. Alternatively, inspection activities may be conducted at a later time following transfer of the fuel to the new fuel storage pit.

Following inspection, unacceptable new fuel assemblies are set aside for dispositioning. Acceptable new fuel assemblies are either inserted into the new fuel storage racks in the new fuel storage pit or placed in the new fuel elevator which is located in the fuel transfer canal. Those assemblies placed in the new fuel elevator are lowered to the bottom of the fuel transfer canal. They are then engaged by the spent fuel handling tool, which is in turn suspended from the fuel handling machine. The fuel handling machine either transfers the assembly to the spent fuel storage racks or to the FTS upender for transfer to the RCB for refueling operations. The upender pivots the assembly to the horizontal position and the FTS fuel container carries it through the fuel transfer tube to an upender inside the Containment.

9.1.4.2.2 Refueling Procedure: The refueling operation follows a detailed procedure to ensure a safe, efficient refueling operation. Prior to initiating refueling, shutdown conditions are as specified in the Technical Specifications. Criticality protection for the refueling operation, including a requirement for checks of boron concentration, is specified in the Technical Specifications.

Protection against uncontrolled rod cluster control assembly (RCCA) bank withdrawal from a subcritical condition is described in Section l5.4.1 and includes source-range, intermediate-range, and power-range high neutron flux trips. The transient is assumed to be terminated by the power-range high neutron flux (low setting) reactor trip. Protection against uncontrolled boron dilution is described in Section l5.4.6.

The following significant points are assured by the refueling procedure:

1. The refueling water and the reactor coolant contain approximately 2,800 ppm boron. This concentration is sufficient to keep the core approximately 5 percent $\Delta k/k$ subcritical during the refueling operations with all control rods removed and the core refueled to provide sufficient excess reactivity for operation to the next refueling outage.

2. The water level in the refueling cavity is high enough to keep the radiation levels within acceptable limits when the fuel assemblies are being removed from the core.

The refueling operation is divided into four major phases: (l) preparation, (2) reactor disassembly, (3) fuel-handling, and (4) reactor assembly. A general description of a typical refueling operation through the four phases is given below.

This description applies to rapid (unrodded) refueling which will normally be used during a refueling shutdown to maximize plant availability. The description also points out the different steps that would be included in a nonrapid (rodded) refueling operation, which is typically used for extended shutdowns involving nonroutine maintenance.

9.1.4.2.2.1 Phase I - Preparation - The reactor is shut down and the Reactor Coolant System is borated and cooled down to refueling shutdown condition. Following initiation of either the normal or supplemental containment purge systems, as required, and a radiation survey of the Containment Building, refueling operations may proceed. The fuel transfer equipment and refueling machines are checked for proper operation.

When the Reactor Coolant System (RCS) has been cooled to less than 200°F, the RCC assemblies (control rods) are withdrawn to their full-out position, and each control rod's holdout device is activated to ensure that the rod is held in its withdrawn position inside its upper internals guide tube and reactor head pressure housing. After the RCCAs are locked in position and RCS has been cooled to 150°F, RCS draining lowers the reactor coolant level to the reactor vessel nozzle centerline, degassing operations using the RCS Vacuum Degassing System (Section 11.3) may be used, if necessary, to remove radioactive gases prior to head removal.

For a normal nonrapid refueling, the preparation for refueling is similar except that the control rods are not withdrawn from the core.

During refueling outages where there is a concern of mechanical binding of the control rods in the fuel assembly guide thimbles during cooldown, the above sequences may be modified. The most likely location of mechanical binding of control rods in the guide thimbles is in the dashpot region in the lower end of the thimble tubes due to smaller radial clearance (see Section 4.2.2.2.3 for a discussion of guide thimble design). If a guide thimble experiences any lateral deformation during cooldown, binding would be expected to first occur in the dashpot region due to the reduced tube ID in this region. Therefore, to preclude binding, the control rods may be withdrawn to a position just above the dashpot region. Due to the lack of rod position indication for the shutdown banks in this region, the shutdown banks may be fully withdrawn. Before repositioning the control rods, in preparation for plant cooldown, the RCS boron concentration is adjusted to ensure the Technical Specification on Shutdown Margin will be maintained with the control rods partially withdrawn. During the cooldown and boration to the refueling boron concentration, the RCS boron concentration is monitored to assure that adequate shutdown margin is maintained.

Control rod drive mechanism (CRDM) binding may be present for one or more control rods after the cooldown described above which would prevent full withdrawal of all of the control rods. In order to resolve this binding, it may be necessary to modify the normal rapid refueling sequence described in this section and below. Actions that may be used to relieve CRDM binding include detensioning the reactor head and lifting the reactor head a small distance (approximately 2 to 4 inches). After the binding is relieved, the control rods would be fully withdrawn and locked out in preparation for moving the reactor head to the storage position. The CRDM would be evaluated for acceptability prior to reuse. The RCS boron concentration would be monitored to ensure the adequate Shutdown Margin is maintained.

For a rapid-refueling outage, the control rods are then fully withdrawn, as described above. For a non-rapid refueling outage, the control rods are reinserted into the fuel assemblies.

9.1.4.2.2.2 Phase II – Reactor Disassembly – For rapid refueling, the seismic tie rods attached to the missile shield are disconnected and stored. The insulation is removed from the vessel head flange area, and the Roto-Lok studs are detensioned and removed from the vessel flange. A stud hole plug is installed in each hole after the stud is removed to prevent entry of water. In addition, all flux mapping detectors and thimbles are retracted through the bottom of the reactor vessel. The refueling cavity is prepared for flooding by removing all tools, closing the refueling canal drain holes and by installing underwater lights. The upper head package (i.e., head, missile, cable bridge, upper internals, control rods, and rod drives) is lifted by the polar crane through air to a height that allows inspection underneath the head. Then, water from the RWST is pumped into the RCS by the LHSI pumps, causing the water to overflow into the refueling cavity. The refueling cavity is flooded to a level just below the closure head. From that point, the vessel head is lifted in conjunction with the water level in the refueling cavity. When the refueling cavity is full, the upper package is moved to storage at the end of the refueling cavity opposite the refueling canal. If a radiation survey indicates the need, additional water shielding may be provided by pulling a vacuum through the reactor vessel head vent connection.

For nonrapid refueling, reactor disassembly includes additional steps starting with disconnecting the cables that run across the cable bridge. This allows the bridge to be lifted by the polar crane separately from the reactor head. The upper internals assembly is then disconnected from the reactor vessel head. After the cable bridge is lifted clear of the reactor head, the head is lifted as necessary to permit a visual inspection of the RCC assembly drive shafts. This ensures that they are free in the control rod drive mechanism (CRDM) housings and were not raised with the reactor head. Movement of the reactor head may then continue independent of the refueling cavity filling activity. The head may be moved without being limited by the water level.

The vessel head is placed on a dry storage pedestal in a roped-off area of the operating floor at the north end of the containment. After filling of the reactor cavity RCC drive shafts are unlatched from their respective RCC assemblies. Finally, the upper internals are removed from the vessel by using the reactor internals lifting device suspended from the polar crane. The internals package is wet-stored on a stand in the north end of the refueling cavity.

9.1.4.2.2.3 Phase III – Fuel Handling - Fuel assemblies are removed from and inserted in to the reactor core by the refueling machine. The fuel assemblies are removed from the core in a sequence which is planned before each refueling. Partially spent fuel assemblies and new fuel assemblies are loaded into the core per approved core loading plan.

The general fuel handling sequence is:

l. The refueling machine is positioned over a fuel assembly in the core.

2. The fuel assembly is lifted by the refueling machine to a predetermined height sufficient to clear the reactor vessel and still leave sufficient water covering the fuel assembly to eliminate any radiation hazard to the operating personnel.

3. The fuel transfer car is moved into the refueling canal from the fuel transfer canal.

4. The FTS fuel assembly container is pivoted to the vertical position by the upender.

5. The refueling machine is moved from over the core to line up the fuel assembly with the fuel assembly container.

6. The refueling machine loads the fuel assembly into the fuel assembly container of the FTS transfer car.

7. The container is pivoted to the horizontal position by the upender.

8. The fuel container is moved through the fuel transfer tube to the fuel transfer canal in the FHB by the transfer car.

9. The fuel assembly container is pivoted to the vertical position by the upender. The fuel assembly is unloaded by the fuel handling tool, which is suspended from the fuel handling machine hoist.

l0. The fuel assembly is placed in the spent fuel storage rack after being transferred through the gate between the fuel transfer canal and the SFP.

11. Partially spent fuel and new fuel assemblies are moved to new positions in the reactor core, from the SFP or in-Containment storage racks to replace the spent fuel assemblies that were removed during the preceding fuel handling steps. In addition, fuel assemblies may be shuffled between core locations provided shutdown margin is maintained.

l2. This procedure is continued until refueling is completed.

During nonrapid refueling, some of the fuel assemblies that are removed from the reactor core will contain a rod cluster control (RCC) (control rod) element. Such assemblies may be placed in the RCC change fixture by the refueling machine. The RCC change fixture is located adjacent to the in-Containment storage racks. Here the RCC element is removed from the spent fuel assembly and deposited in another fuel assembly previously placed in the RCC change fixture.

Another step generally performed during either rapid or nonrapid refueling is the removal of an irradiated specimen from the reactor core for examination. Also, remote television camera inspections of the core and reactor vessel are performed.

9.1.4.2.2.4 Phase IV – Reactor Assembly - Reactor assembly, following refueling, is essentially achieved by reversing the operations given in "Phase II - Reactor Disassembly".

9.1.4.2.3 Spent Fuel Shipment: Construction of Spent Fuel Cask handling System has been deferred and Nuclear Regulatory Commission was notified per ST-HL-AE-2149, dated May 26, 1987, "Unit 1 Statement of Completion and Request for Low Power Operating License" and per ST-HL-AE-2870, dated December 3, 1988; "Unit 2 Statement of Completion and Request for Low Power Operating License," General arrangements of the cask handling area are listed as Figures 1.2-39 through 1.2-46 in Table 1.2-1. Installation of pool liner plates and permanent removable gates in the cask handling area is not complete. The following is a general description of the cask handling system and the procedure to be utilized for offsite shipment of spent fuel after completion of the cask handling system. Spent fuel is to be shipped offsite by truck in spent fuel shipping casks licensed for use by the Department of Transportation (DOT). CN-3169

Upon receipt in the FHB, the spent fuel cask shipping vehicle (rail or truck) is braked and blocked in position for removal of the spent fuel cask. The cask is then inspected for shipment damage and to ascertain the degree of additional cleaning that will be required to remove road dirt or radioactive contamination from the cask surface. The gate between the cask loading pool and the decontamination area is removed using the 15/2-ton FHB overhead crane.

The upper and lower spent fuel cask impact structures are removed, and spent fuel cask appurtenances are disconnected. The spent fuel cask yoke is removed from its storage area and attached to the spent fuel cask trunnions using the l50-ton, overhead cask-handling crane. As the spent fuel cask is upended, the yoke is maintained in a vertical position by lateral movement of the overhead spent fuel cask handling crane trolley. (The reverse procedure is performed when the cask is loaded onto the shipping vehicle.) The spent fuel cask is then lifted clear of the shipping vehicle, moved over to the access bay, and lowered to the decontamination area, where any additional cleaning of road dirt or surface contamination is performed.

Using the l50-ton, overhead cask-handling crane, which is still connected to the cask, the spent fuel cask is lifted, moved horizontally, and lowered into the cask loading pool. The lifting yoke is removed and placed in its storage location. The spent fuel cask head is unbolted and moved, using the FHB overhead crane, to a temporary storage location. The gate between the cask loading pool and the decontamination area is replaced. The cask loading pool and channel are filled with borated water to the same level as the SFP (nominally El. 66 ft-6 in.). The two gates between the cask loading pool and the SFP are removed, by the l5/2-ton (15-ton main hook and a 2-ton auxiliary hook) FHB overhead crane, and fuel transfer is initiated. Loading of the spent fuel assemblies is accomplished in the following manner: the spent fuel assembly in the SFP is engaged by the long spent fuel handling tool, which is in turn attached to the fuel-handling machine; the fuel assembly is removed from the storage rack and transferred through the gate area into the cask loading pool and then lowered into the spent fuel cask. The height to which the spent fuel assembly can be lifted is restricted by the length of the spent fuel handling tool and the fuel-handling machine design in order to provide a minimum of l0 ft of shielding water above the spent fuel assembly. This spent fuel handling procedure is repeated until the spent fuel cask is full. The gates sealing the cask loading pool from the SFP are then replaced using the l5/2-ton FHB overhead crane.

The spent fuel cask head is lifted from its storage area using the l5/2-ton overhead FHB crane and placed on the spent fuel cask. The cask head bolts that secure the cask head to the cask are installed and tightened "finger tight" using long-handled tooling operated from the fuel-handling machine.

The cask loading pool level is lowered to at least 6 in. below the bottom of the gate between the cask loading pool and the decontamination area. This gate is removed using the 15/2-ton overhead crane. Using the l50-ton cask-handling crane, the cask-lifting yoke is attached to the cask-lifting trunnions and the cask is transferred from the cask loading pool to the cask decontamination area. A radiological survey is made of the cask to determine the extent of cask decontamination necessary. The head bolts are torqued to the proper value, and various preshipment testing requirements characteristic of the spent fuel cask being used are completed. These tests may include a cask leak test and monitoring of cask coolant activity. The contaminated outside surface areas are manually decontaminated using high-pressure sprayers or by using scrub brushes with detergent, rinses, and wipes. Once the cask is decontaminated and has passed the preshipment testing requirements, it is lifted back through the access bay and returned to its horizontal position on the shipping vehicle. The cask holddown mechanisms are secured, the cask top and bottom impact limiters are replaced, and all appropriate appurtenances are reconnected. Shipping papers are completed and the cask is removed from the FHB and released for shipment.

9.1.4.2.4 Component Description:

9.1.4.2.4.1 Refueling Machine - The refueling machine (Figure 9.1.4-1) is a rectilinear bridge and trolley crane with a vertical mast extending down into the refueling cavity. The bridge spans the refueling cavity and runs on rails set into the edge of the refueling cavity. The bridge and trolley motions are used to position the vertical mast over a fuel assembly in the core. A long tube, with a pneumatic gripper on the end, is lowered down out of the mast to grip a fuel assembly. The gripper tube is long enough so that the upper end is still contained in the mast when the gripper end contacts the fuel. A winch mounted on the trolley raises the gripper tube and fuel assembly up into the mast tube. The fuel is transported while inside the mast tube to its new position.

The refueling machine drive uses an alternating current variable frequency control system. The system includes an inverter, which allows the frequency to the motor to be varied from zero to full speed.

All controls for the refueling machine are mounted in a console on the trolley. The bridge and trolley are positioned by a servo system in relation to an X-Y coordinate grid pattern referenced to the reactor core. Bridge and Trolley position is indicated by a closed circuit TV system. The Video Positioning Indication System is mounted in the faceplate of the control console. The monitor displays the position that is determined by aligning the target on the side of the control console with the required position address on the positioning scale on the monitor. The drives for the bridge, trolley, and winch are variable speed and include a separate inching control on the bridge and trolley. The maximum speed is 60 ft/min for the bridge and 40 ft/min for the trolley. The hoist is set at 21 ft/min. An auxiliary monorail hoist on the refueling machine uses a two-step magnetic controller to give hoisting speeds of approximately 7 ft/min and 20 ft/min for use in handling accessory equipment.

Programmable Logic Controller (PLC) based interlocks and PLC limit switches on the bridge and trolley drives prevent damage to the fuel assemblies. The winch is also provided with redundant limit switches plus a mechanical stop to prevent a fuel assembly from being raised above a safe shielding depth should the limit switch fail. In an emergency, the bridge, trolley, and winch can be operated manually using a handwheel on the motor shaft.

9.1.4.2.4.2 Fuel Handling Machine - The fuel handling machine consists of an electric monorail hoist carried on a wheel-mounted bridge (Figure 9.1.4-2), which spans the SFP, fuel transfer canal, and cask loading pool. The fuel handling machine is used exclusively for handling fuel assemblies and core components by means of handling tools suspended from the hoist. The hoist travel and tool lengths are designed to limit the maximum lift of a fuel assembly or core component to a safe shielding depth.

The fuel handling machine has a two-step magnetic controller for the bridge and hoist. The bridge speeds are l0 ft/min and 30 ft/min, and the hoist speeds are 7 ft/min and 20 ft/min. A hydraulic coupling is used in the bridge drive to limit starting acceleration. The hoist trolley is manually positioned along the monorail by a chainfall.

9.1.4.2.4.3 New Fuel Elevator - The new fuel elevator (Figure 9.1.4-3) consists of a box-shaped elevator assembly with its top end open and sized to house one fuel assembly.

The new fuel elevator is normally used to lower a new fuel assembly into the fuel transfer canal, where the fuel handling machine can transport it to the FTS equipment for transfer into the Containment. The new fuel elevator can also be used to raise a new or spent fuel assembly provided administrative controls and procedures are utilized.

9.1.4.2.4.4 Fuel Transfer System - The FTS (Figure 9.1.4-4) includes an underwater, electric-motor-driven transfer car that runs on tracks extending from the refueling canal in the RCB through the fuel transfer tube and into the fuel transfer canal in the FHB, and a hydraulically actuated lifting arm (upender) at each end of the transfer tube. In the refueling canal the fuel container mounted on the transfer car receives a fuel assembly in the vertical position from the refueling machine. The upender then lowers the fuel assembly to a horizontal position for passage through the transfer tube. After passing through the tube, the fuel container is raised to a vertical position by the other upender for removal of the fuel assembly. The fuel handling machine lifts the fuel assembly out of the fuel container and moves it to the desired storage position in the spent fuel storage racks.

The transfer car is driven by a pusher arm connected to a cable drive system. The electric motor driven cable drive system is mounted above water. This drive system utilizes a single winch with two separate cables to drive the transfer car forward and back. The fuel container is center-pivoted, and the pivot structure serves to attach the container to the transfer car so they move together as a single unit. There is a mechanical stop at each end of the rail on which the car travels. Also, there is another mechanical stop for the vertical limit of travel when the fuel container is upended. Each of the upender lifting arms has its own hydraulic power unit and control console located on the operating floor of its respective side of the Containment wall.

During reactor operation, the transfer car is stored in the fuel transfer canal. A blind flange is bolted on the refueling canal end of the transfer tube to seal the Reactor Containment. The end of the tube in the FHB is closed by a gate valve.

9.1.4.2.4.5 Rod Cluster Control Change Fixture - The RCC change fixture is located in the in-Containment fuel storage pit. The change fixture may be used for periodic RCC element inspections and for transfer of the RCC elements from one fuel assembly to another, or transfer of secondary source assemblies from one fuel assembly to another (Figure 9.1.4-5). During rapid refueling operations, the RCC change fixture is not required for transfer of RCC elements since the

RCC elements are removed from the reactor core along with the upper head package. The major subassemblies which constitute the change fixture are the frame and track structure, the carriage, the guide tube, the gripper, and the drive mechanism. The carriage is a moveable container supported by the frame and track structure. The tracks provide a guide for the four flanged carriage wheels and allow horizontal movement of the carriage during the changing operation. The positioning stops on both the carriage and frame locate each of the three carriage compartments directly below the guide tube. Two of these compartments are designed to hold individual fuel assemblies while the third is made to support a single core component (e.g., RCCA or secondary source assembly). Situated above the carriage and mounted on the in-Containment fuel storage pit wall is the guide tube. The guide tube provides proper orientation of the gripper and core component as they are being raised and lowered. The gripper is a pneumatically actuated mechanism which engages the core component. It has two flexure fingers which can be inserted into the top of the core component when air pressure is applied to the gripper piston. Normally, the fingers are locked in a radially extended position. Mounted on the operating deck is the drive mechanism assembly, which is composed of the manual carriage drive mechanism, the revolving stop operating handle, the pneumatic selector valve for actuating the gripper piston, and the electric hoist for elevating the gripper.

The pneumatic gripper and winch lift the core component out of a spent fuel assembly and up into the guide tube. Then by repositioning the carriage, a new fuel assembly is brought under the guide tube and the gripper lowers and releases the core component into the new fuel assembly. The refueling machine loads and unloads the fuel assemblies into and from the carriage.

9.1.4.2.4.6 Spent Fuel Assembly Handling Tool - The spent fuel assembly handling tool (Figure 9.1.4-6) is used to handle new and spent fuel assemblies in the spent fuel pit. It is a manually actuated tool, suspended from the fuel handling machine. The gripping portion of the tool consists of a mechanical finger which engages the fuel assembly top nozzle when actuated. The operating handle to actuate the fingers is located at the top of the tool. When the fingers are latched, a pin is inserted into the operating handle, to prevent the fingers from being accidentally unlatched during fuel handling operations.

9.1.4.2.4.7 New Fuel Assembly Handling Tool - The new fuel assembly handling tool (Figure 9.1.4-7) is used to lift and transfer fuel assemblies from the new fuel shipping containers to the new fuel storage racks, or to the new fuel elevator. It is a manually actuated tool, suspended from the FHB overhead crane, which uses four cam-actuated latching fingers to grip the underside of the fuel assembly top nozzle. The operating handles which actuate the fingers are located on the side of the tool. When the fingers are latched, a safety screw is turned in to prevent the accidental unlatching of the fingers.

9.1.4.2.4.8 Reactor Vessel Head and Upper Internals Lifting Device - The reactor vessel head and upper internals lifting device consists of a welded and bolted structural steel frame with suitable rigging to enable the crane operator to lift the head or the head and upper internals for storage during refueling operations. The lifting device normally remains attached to the reactor vessel head during plant operation. The missile shield and the control rod drive mechanism cooling shroud are attached to the head lifting device.

9.1.4.2.4.9 Reactor Internals Lifting Device - For rapid refueling, the upper internals are normally lifted in one lift as part of the upper head package. For nonrapid refueling, the head may be separated from the upper internals and lifted separately. In this case, the reactor internals lifting rig (Figure 9.1.4-8) is used to remove the upper internals.

9.1.4.2.4.10 Reactor Vessel Stud Tensioner - Stud tensioners are employed to secure or release the head closure joint at every refueling. The stud tensioner is a hydraulically operated device. The device permits preloading and unloading of the reactor vessel closure studs at cold shutdown conditions. Stud tensioners minimize the time required for the tensioning or unloading operation. A single hydraulic pumping unit operates the tensioners, which are hydraulically connected in parallel. The studs are tensioned to their operational load in steps to prevent high stresses on the reactor vessel flange and unequal loading of the studs.

9.1.4.2.4.11 Spent Fuel Cask - The design of cask storage and cask handling facilities is based on a design cask weighing up to 150 tons and measuring approximately 21 ft long by 10 ft in diameter. The shipping vehicle (rail car or truck) will take the cask to and from the FHB and will be equipped with a cask-cooling system and a storage area for the cask yoke. The FHB arrangement and cask-handling equipment are designed to preclude the occurrence of any accident to a loaded spent fuel shipping cask beyond the regulatory-specified design accident conditions for the cask. Overland offsite transportation of the cask will conform to transportation rules and regulations, 49CFR173.

9.1.4.2.4.12 Fuel Handling Building Overhead Crane - This 15/2-ton overhead crane runs over the entire FHB area. Travel of this crane is shown on Figure 9.1.4-13. The design services of this crane include the following:

1. Transfer of new fuel assembly shipping containers from the shipping vehicle to the new fuel handling area.

2. Transfer of new fuel assemblies from new fuel shipping containers to new fuel elevator or new fuel storage pit.

3. Transfer of spent fuel shipping cask head from the cask to temporary storage on the FHB operating floor and then back onto the shipping cask when the fuel loading is complete.

4. Replacement of safety injection and Containment spray pumps and SFP cooling HXs.

5. Removal and replacement of pool gates for fuel transfer operations.

9.1.4.2.4.13 New Fuel Handling Area Overhead Crane - This 5-ton overhead crane can be used to handle new fuel assemblies and their shipping containers in the new fuel handling area.

9.1.4.2.5 Industrial Codes and Standards: The following industrial codes and standards are used in the design of fuel-handling equipment.

1. Cranes: Crane Manufacturers Association of America (CMAA) specification No. 70, Class A-1.

2. Structural: ASME Code, Section III, Appendix XVII.

3. Electrical: Applicable standards and requirements of the National Electric Code, National Fire Protection Association No. 70, and National Electrical Manufacturers Association standards MGI and ICS are used in the design, installation, and manufacturing of all electrical equipment.

4. Materials: Materials conformed to the specifications of the American Society for Testing Materials standard.

5. Safety: The design meets the applicable requirements of Section l9l0.179 of Subpart N of the Occupational Safety and Health Act Code.

6. Others: American Institute of Steel Construction; American National Standards Institute; American Society of Testing Materials; Institute of Electrical & Electronic Engineers; National Electric Manufacturers Association; Occupational Safety & Health Administration; American Welding Society; Expansion Joint Manufacturers Association; ASME B&PV Code Sections VIII and XI; American Concrete Institute; Hydraulic Institute Standards.

9.1.4.3 Safety Evaluation. Design of the FHS in accordance with RG l.13 and with GDCs 2, 5, 61, and 62 ensures a safe condition under normal and postulated accident conditions.

9.1.4.3.1 Safe Handling:

9.1.4.3.1.1 Design Criteria for the Refueling Machine and the Fuel-Handling Machine - The primary design requirement of the machine is reliability. A conservative design approach is used for all load-bearing parts. Where practicable, components are used that have a proven record of reliable service. Throughout the design, consideration is given to the fact that the machine will spend long idle periods stored in an atmosphere of 80°F and high humidity. In general, the crane structure is considered in the Class Al, Standby Service, as defined by CMAA Specification No. 70.

All components critical to the operation of the machine and parts which could fall into the reactor are positively restrained from loosening.

9.1.4.3.1.2 Refueling Machine - The refueling machine design includes the following provisions to ensure safe handling of fuel assemblies:

l. The Programmable Logic Controller (PLC) Interlocks

   The PLC interlocks which ensure safe operation of the crane are designed to meet single-failure criteria.

2. Bridge, Trolley, and Hoist Drive Mutual Interlocks

   Bridge, trolley, and winch drives are mutually interlocked using redundant PLC interlocks to prevent simultaneous operation of any two drives, and therefore can withstand a single failure.

3. Bridge Trolley Drive Gripper Tube Up

   Bridge and trolley drive operation in fast speed is prevented except when the "gripper tube up" position switches are actuated. The PLC interlock is redundant and can withstand a single failure.

4. Gripper Interlock

A PLC interlock is supplied which prevents the opening of a solenoid valve in the air line to the gripper except when there is less than 600 pounds of suspended weight indicated on a load cell. As backup protection for this PLC interlock, the mechanical weight-actuated lock in the gripper prevents opening of the gripper under load even if air pressure is applied to the operating cylinder. The PLC interlock is redundant and can withstand a single failure.

5. Excessive Suspended Weight

An excessive suspended weight load cell limit switch and a backup deflection-actuated limit switch prohibit raising the guide tube if the load suspended from it significantly exceeds the weight of the gripper, a fuel assembly, and an RCCA. Load limits are designed into the PLC software and are accessible through variable memory. The variable memory is used to add or change weight set points that are stored in the PLC logic. Each load set point is identified by switch number, a control relay assignments, and a variable location. The PLC interlock is intended to prevent inadvertent damage to a fuel assembly or adjacent components if the assembly becomes stuck during its removal.

6. Hoist-Gripper Position Interlock

A PLC interlock in the hoist drive circuit in the up direction permits the hoist to be operated only when the open or closed indicating switch on the gripper is actuated. The hoist-gripper position PLC interlock consists of two separate circuits that work in parallel such that one circuit must be closed for the hoist to operate. If one or both interlocking circuits fail in the closed position, an audible and visual alarm on the console is actuated. The PLC interlock, therefore, is not redundant but can withstand a single failure since both an interlocking circuit and the monitoring circuit must fail to cause a hazardous condition.

7. Bridge and Trolley Hold-Down Devices

Both the refueling machine bridge and trolley are horizontally restrained on the rails by two pairs of guide rollers, one pair at each wheel location on one truck only. The rollers are attached to the bridge truck and contact the vertical faces on either side of the rail to prevent horizontal movement. Vertical restraint is accomplished by antirotation bars located at each of the four wheels for both the bridge and trolley. The antirotation bars are bolted to the trucks and extended under the rail flange for the bridge restraint; the trolley restraints extend beneath the top flange of the bridge girder which supports the trolley rail. Both horizontal and vertical restraints are adequately designed to withstand the forces and overturning moments resulting from an SSE.

8. Design Load

The design load for structural components is their deadweight plus 5,700 pounds (three times the weight of a fuel assembly and RCCA).

9. Main Hoist Braking System

The main hoist is equipped with three independent braking systems. There are two holding (electrical) brakes: one on the motor end and one on the other side of the gear box. The holding brakes operate normally to release upon application of current and to set when current is interrupted. The third brake is a mechanically actuated load control brake internal to the hoist gear box; it sets if the load starts to overhaul the hoist. It is necessary to apply torque from the motor to raise or lower the load. In raising the motor cams, the brake opens; in lowering, the motor slips the brake, allowing the load to lower. The brake actuates upon loss of torque from the motor for any reason and is not dependent upon electrical power. The brake ratings and design meet or exceed the requirements of the Crane Manufacturer's Association of America (CMAA) specification No. 70 1975.

The Main Hoist Braking System is supplied with redundant paths of load support such that failure of any one component will not result in free fall of the fuel assembly. Two wire ropes are anchored to the winch drum and carried over independent sheaves to a load equalizing mechanism on the top of the gripper tube. In addition, supports for the sheaves and equalizing mechanism are backed up by passive restraints to pick up the load in the event of failure of this primary support. Each cable system is designed to support 13,750 pounds or 27,500 pounds acting together.

10. Hoist Down Limit

A PLC geared limit switch system on the main hoist prevents elevation signals from the hoist-mounted resolver to the PLC in the control console. This prevents lowering the gripper tube significantly below the position that would normally engage a fuel assembly in the reactor core.

The working load of fuel assembly, RCCA, and gripper is approximately 2,850 pounds.

The gripper itself has four fingers gripping the fuel, any two of which will support the fuel assembly weight.

The gripper mechanism contains a spring-actuated mechanical lock which prevents the gripper from opening unless the gripper is under a compressive load.

The refueling machine gripper and hoist system are routinely load tested prior to refueling operations in accordance with the surveillance requirements of the Technical Requirements Manual.

9.1.4.3.1.3 Fuel-Handling Machine - The fuel-handling machine includes the following safety features:

1. The bridge and hoist controls are interlocked to prevent simultaneous operation of both the bridge drive and the hoist. The interlocks are redundant and can withstand a single failure.

2. A redundant overload protection device is included on the hoist to limit the uplift force which could be applied to the spent fuel storage racks. The protection device limits the hoist load to 125 percent (5,000 pounds) of the rated 2-ton hoist capacity. This device can withstand a single failure. A load-monitoring device is provided between the hoist and spent fuel handling tool. By monitoring drag load when raising or lowering assemblies, it can be determined immediately if the assembly is hanging or experiencing unusual loads.

3. The design load on the hoist is the weight of one fuel assembly and RCCA (1,900 pounds), one failed fuel container (1,700 pounds), and the tool (400 pounds), which gives it a total weight of approximately 4,000 pounds.

4. Restraining bars are provided on each truck to prevent the bridge from overturning.

9.1.4.3.1.4 Fuel Transfer System - The following safety features are provided for in the FTS:

l. Transfer Car Permissive Switch

The transfer car controls are located in both the FHB and the RCB. Control of system can happen from either control consoles. The two consoles are interconnected and the FHB side console controls the winch to move the carriage. There is a Local/Remote switch located on the RCB side control console which can transfer the system control to a remote auto station located on the Refueling Machine to allow auto operation of the Fuel Transfer System from the Refueling Machine provided the required system interlock conditions are met.

Transfer car operation is possible only when both upender lifting arms are in the down position as indicated by the proximity switches. The switches and the controls in the consoles prevent movement of the car unless the upender frames are in down position. If a switch failure occurs, a second set of the contacts in the switches can be selected. Additionally emergency stop switches are provided at all operating stations to stop the movement of the car if visible conditions warrant it.

2. Lifting Arm Transfer Car Position

Two redundant safety features allow lifting arm operation only when the transfer car is at the respective end of its travel and therefore can withstand a single failure.

Of the two redundant safety features that allow lifting arm operation only when the transfer car is at the end of its travel, one feature is a position limit switch in the control circuit. The second feature is that the fuel container of the transfer car has a T-slot which engages a T-lug on the upender only when in the correct position for upending.

3. Transfer Car Valve Open

Two redundant interlocks features on the transfer tube valve permit operation of the transfer car only when the transfer tube valve position switch indicates the valve is fully open and, therefore, can withstand a single failure.

4. Transfer Car Upender

The transfer car upender interlock is primarily designed to protect the equipment from overload and possible damage if an attempt is made to move the car when the fuel container is in the vertical position. This interlock is redundant and can withstand a single failure. The basic interlock is a position limit switch in the control circuit. The backup interlock is a mechanical latch device that is opened by the weight of the fuel container when in the horizontal position.

5. Upender Refueling Machine

The refueling canal upender is interlocked with the refueling machine. Whenever the transfer car is located in the refueling canal, the upender cannot be operated unless the refueling machine mast is in the fully retracted position or the machine is over the core.

9.1.4.3.1.5 Fuel Handling Tools and Equipment - All fuel handling tools and equipment which are used over the open reactor vessel are designed to prevent inadvertent decoupling from crane hooks; i.e., lifting rigs are pinned to the crane hook and safety latches are provided on hooks supporting tools. Tools required for handling internal reactor components are designed with fail-safe features that prevent disengagement of the component in the event of operating mechanism malfunction. These safety features apply to the following tools:

l. Control Rod Drive Shaft Unlatching Tool

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

2. Spent Fuel Handling Tool

When the fingers are latched, a pin is inserted into the operating handle to prevent inadvertent actuation. The tool weighs approximately 400 pounds and is preoperationally tested at l25 percent of the weight of one fuel assembly and RCCA (l,900 pounds).

3. New Fuel Assembly Handling Tool

When the fingers are latched, a safety screw is inserted to prevent inadvertent actuation. The tool weighs approximately l00 pounds and is preoperationally tested at l25 percent of the weight of one fuel assembly and RCCA (l,900 pounds).

9.1.4.3.1.6 Overhead Cranes - Overhead cranes used in refueling and fuel handling operations include the 310/15-ton polar crane, the l50-ton cask-handling crane, the l5/2-ton FHB crane, and the 5-ton new fuel handling area crane. In addition, two jib cranes were added to each RCB. These jib cranes are intended to assist in various maintenance activities during the refueling outages. These cranes are classified as non-nuclear safety (NNS) Class since they neither provide nor support any safety system function. However, during and after a seismic event, the cranes and their supports are designed to retain structural integrity and prevent collapse and damage to safety-related equipment and structures. Operability need not be retained.

A report under separate cover has been submitted to the Nuclear Regulatory Commission (NRC) concerning control of heavy loads. This report contains details of crane/load combinations and the safeguards that prevent damage to spent fuel, the reactor core, equipment required for safe shutdown, and decay heat removal. The requirements given in the report have been implemented by station procedures. This report was part of the response in references 9.1-1, 9.1-2, 9.1-3 and 9.1-4.

l. Polar Crane

The polar crane is used for general handling operations in the containment during refueling. These operations include:

a. Removal of the upper package

b. Removal of pumps, pump motors, and heat exchangers

c. Handling of pool gate

d. Handling of inservice inspection (ISI) rig

e. Movement of hatch covers.

A head drop analysis is discussed in Letter NS-CE-ll0l (June 11, l976) and received NRC approval by letter on November 30, l976. The assumptions in the head drop analysis concerning restrictions on load height, load weight, and medium present under the load have been incorporated into station procedures. This crane is provided with seismic restraints to prevent derailment in the event of an SSE.

2. Cask-Handling Overhead Crane

This l50-ton crane is provided for handling the spent fuel shipping cask. Crane design and building arrangement preclude travel of this crane over the SFP; consequently, the shipping cask cannot be lifted or dropped over the spent fuel racks. This crane is designed to maintain its structural integrity and hold its load under the dynamic loading conditions of the SSE. Building arrangement and lifting rig design prevents this crane from lifting the cask higher than 30 ft above the floor. The spent fuel cask drop accident is discussed in Section l5.7.5.

3. Fuel-Handling Building Overhead Crane

The l5/2-ton capacity crane is to be used for general handling operations in the FHB. These operations include:

a. Movement of new fuel assemblies

b. Removal of pumps and heat exchangers

c. Handling of the pool gates

d. Movement of the cask head

e. Movement of hatch covers

This crane is designed to maintain its structural integrity under the dynamic loading of the SSE. The crane will retain its load under such dynamic loadings.

This crane main hoist is also provided with a redundant receiving system. With this redundancy, the crane can withstand a single failure without dropping its load and therefore meets the intent of RG l.104. A more detailed description of compliance of the l5/2-ton FHB crane with RG l.104 is given in Table 9.1-3.

4. New Fuel Handling Area Overhead Crane

The 5-ton new fuel handling area overhead crane is used for movement of new fuel assemblies within the new fuel handling area. Dropping of new fuel assemblies due to SSE-induced dynamic loading of the crane will not result in an offsite radiological hazard. The crane travels over no safety-related equipment.

5. Jib Cranes in the RCB

The jib cranes in the RCB are mounted to platforms on top of the Secondary Shield Wall. These are pedestal cranes as defined in ASME B30.4. The top portion of these jib cranes can rotate 360 degrees. However, physical stops are installed to prevent the boom from traveling over fuel in the open reactor vessel or in the ICSA and during fuel movement. Each crane's boom can be raised and lowered and retracted and extended out for a total reach of 60 feet. The primary purpose intended for these cranes is to assist in general maintenance and HP activities. Limited by specific configurations the cranes can lift a maximum of 11,000 lbs.

9.1.4.3.2 Seismic Considerations: The safety classifications for all fuel handling and storage equipment are listed in Table 3.2.B-2. SC l, 2, and 3 equipment is designed to withstand the effects of an SSE without loss of capability to perform its safety function. Further, the combined normal and SSE stresses are limited to the allowable stresses as defined by ASME Code, Section III, Appendix XVII-2ll0. SC l and 2 equipment is designed to withstand the forces of an Operating Basis Earthquake (OBE), with the combined normal and OBE stresses being limited to the allowable stresses, as defined by ASME Code, Section III, Appendix XVII. For SC 3 equipment, consideration is given to the OBE only insofar as failure of the SC 3 equipment might adversely affect SC l or 2 equipment.

For NNS equipment, design for the SSE is considered if failure might adversely affect a SC l, 2, or 3 component. Design for OBE is considered if failure of the NNS component might adversely affect an SC l or 2 component.

9.1.4.3.3 Containment Pressure Boundary Integrity: The fuel transfer tube, which connects the refueling canal (inside the RCB) and the SFP (outside the Containment), is closed on the refueling canal side by a blind flange at all times except during refueling operations. Further discussion on the fuel transfer tube can be found in Section 3.8.2.1.3.3.

9.1.4.3.4 Radiation Shielding: During all phases of spent fuel transfer, the gamma dose rate at the level of the operating deck from the fuel assembly being transferred is 2.5 mR/hr or less. This is accomplished by maintaining adequate water shielding above the top of the fuel assembly during all handling operations.

The two machines used to lift spent fuel assemblies are the refueling machine and the fuel handling machine. The refueling machine contains positive stops, which ensure that an adequate amount of water shielding is maintained. The hoist on the fuel handling machine moves spent fuel assemblies with a long-handled tool. Hoist travel and tool length likewise limit the maximum lift of a fuel assembly to maintain adequate shielding in the SFP.

9.1.4.4 Tests and Inspections. As part of normal plant operations, the fuel handling equipment is inspected for operability before each refueling operation. During the operational testing of this equipment, procedures are followed that will verify the correct performance of the FHS interlocks.

9.1.4.5 Instrumentation Requirements. A description of the instrumentation and controls is provided in Section 9.1.4.3 for the refueling machine, the fuel handling machine, the FTS, and the SFCHS.

REFERENCES

Section 9.1:

9.1-1 Houston Lighting & Power to Nuclear Regulatory Commission, Response to Generic Letter 81-07, “Control of Heavy Loads,” dated August 24, 1981 (ST-HL-AE-718).

9.1-2 Houston Lighting & Power to Nuclear Regulatory Commission, Submittal of Revised Response to Generic Letter 81-07, “Control of Heavy Loads,” dated October 19, 1984 (ST-HL-AE-1129).

9.1-3 Houston Lighting & Power to Nuclear Regulatory Commission, Response to Generic Letter 81-07, “Control of Heavy Loads,” dated September 5, 1986 (ST-HL-AE-1738).

9.1-4 Houston Lighting & Power to Nuclear Regulatory Commission, Response to Generic Letter 81-07, “Control of Heavy Loads,” dated January 27, 1987 (ST-HL-AE-1862).

TABLE 9.1-1

SPENT FUEL POOL COOLING AND CLEANUP SYSTEM DESIGN PARAMETERS [6]

MODE	FUEL LOAD PER SRP 9.1.3	STPEGS FUEL LOAD (ACTUAL)	MAX ALLOWABLE POOL TEMPERATURE (PER SRP 9.1.3	MAX STPEGS POOL TEMPERATURE (1 COOLING TRAIN)	MAX STPEGS POOL TEMPERATURE (2 COOLING TRAIN)	HEAT LOAD (10^6BTU/HR)
Normal	1/3 core - 150 hrs 1/3 core – 1 yr 1/3 core – 400 days	N/A	N/A	131.2°F	118.7°F	16.6
Normal Maximum	N/A	1/3 core - 140 hrs 1/3 core – 1 yr 1/3 core – 2-26 yrs[1]	140°F	145.7°F	126.0°F	25.5
	N/A	1/3 core - 80 hrs 1/3 core – 1 yr 1/3 core – 2-26 yrs[1]	N/A	150.7°F	129.2°F	29.3
Abnormal Maximum	1 core - 150 hrs 1/3 core – 36 days 1/3 core – 400 days	1 core - 120 hrs 1/3 core – 36 days 1/3 core – 1 yr 1/3 core – 2-26 yrs[5]	No Boiling [2,3]	N/A	155.4°F[4]	63.2

1. Full core discharge capability is maintained, i.e., 1776 fuel assemblies.

2. In the event of a fire or moderate energy line crack in the Fuel Handling Building that disables both trains of spent fuel pool cooling, the spent fuel pool may eventually boil. Makeup can be provided via the reactor makeup pumps. In addition, makeup water can also be supplied to the spent fuel pool using local hose stations in the FHB. See Section 3.3 of the Fire Hazards Analysis Report (FHAR).

3. If both reactor makeup water pumps are lost as a result of flooding in the Mechanical Auxiliary Building (MAB), a seismic Category I makeup source would be available by connecting temporary hoses to the vent and drain valves located on the low head safety injection pump discharge piping so that refueling water could be delivered to the spent fuel pool.

4. Temperature based on STPEGS fuel load. SRP fuel load value would be lower.

5. All fuel storage locations filled with spent fuel, i.e., 1969 fuel assemblies.

6. The heat loads and associated maximum SFP water temperature are based on assumptions identified in the Standard Review Plan for a typical 12-month fuel cycle. Administrative controls ensure the maximum water temperature does not exceed 150.7°F during normal and refueling operations, regardless of fuel cycle length.

TABLE 9.1-2

SPENT FUEL POOL COOLING AND CLEANUP SYSTEM
COMPONENT DESIGN PARAMETERS

Spent Fuel Pool Cooling Pump	
Number	2
Design pressure, psig	150
Design temperature, °F	200
Design flow, gal/min	2,500
Material	Stainless steel
Spent Fuel Pool Skimmer Pump	
Number	1
Design pressure, psig	150
Design temperature, °F	200
Design flow, gal/min	100
Design head, ft	50
Material	Stainless steel

TABLE 9.1-2 (Continued)

SPENT FUEL POOL COOLING AND CLEANUP SYSTEM
COMPONENT DESIGN PARAMETERS

Refueling Water Purification Pump

Number	1
Design pressure, psig	150
Design temperature, °F	200
Design flow, gal/min	200
Material	Stainless steel

Spent Fuel Pool Heat Exchanger

Number		2
Design heat transfer, Btu/hr		9.1×10^6
	Shell	Tube
Design pressure, psig	150	150
Design temperature, °F	200	200
Design flow, lb/hr	1.5×10^6	1.4×10^6
Inlet temperature, °F	105	120
Outlet temperature, °F	111.1	113.6
Fluid circulated	Component cooling water	Spent fuel cooling water
Material	Carbon steel	Stainless steel

TABLE 9.1-2 (Continued)

SPENT FUEL POOL COOLING AND CLEANUP SYSTEM
COMPONENT DESIGN PARAMETERS

Spent Fuel Pool Demineralizer	
Number	2
Design pressure, psig	300
Design temperature, °F	250
Design flow, gal/min	250
Resin volume, ft^3	75
Material	Austenitic stainless steel
Spent Fuel Pool Filter	
Number	2
Design pressure, psig	300
Design temperature, °F	250
Design flow, gal/min	250
Filtration requirement	As required for the retention of ion exchanger resin fines
Material, vessel	Austenitic stainless steel

TABLE 9.1-2 (Continued)

SPENT FUEL POOL COOLING AND CLEANUP SYSTEM
COMPONENT DESIGN PARAMETERS

Spent Fuel Pool Skimmer Filter	
Number	1
Design pressure, psig	300
Design temperature, °F	250
Design flow, gal/min	250
Filtration requirement	As required for Spent Fuel Pool Cleanup
Material, vessel	Austenitic stainless steel
Spent Fuel Pool Strainer	
Number	2
Design pressure, psig	Not applicable
Design temperature, °F	200
Design flow, gal/min	5,000
Material	Austenitic stainless steel

TABLE 9.1-2 (Continued)

SPENT FUEL POOL COOLING AND CLEANUP SYSTEM
COMPONENT DESIGN PARAMETERS

Spent Fuel Pool Skimmer/Suction Head Assembly

Number	2
Design pressure, psig	50
Design temperature, °F	200
Design flow, gal/min	50
Material	Austenitic stainless steel

In-Containment Storage Area Strainer

Number	1
Design pressure, psig	Not applicable
Design temperature, °F	200
Design flow, gal/min	2,500
Material	Austenitic stainless steel

TABLE 9.1-3

FHB 15/2-TON CRANE – COMPLIANCE WITH REGULATORY GUIDE 1.104

Regulatory Position	STPEGS Complies with Rev. 0	STPEGS Meets the Intent of Rev. 0 and Complies with a Proposed Revision Dated January 1978	STPEGS Takes Exception to Rev. 0	Not Applicable by Either Rev. 0 or the Proposed Revision Dated January 1978
C.1.a				X
1.b(1)	X			
(2)				X
(3)				X
(4)				X
1.c	X			
1.d	X			
1.e	X			
1.f		X		
C.2.a	X			
2.b	X			
2.c	X			
2.d	X			
C.3.a	X			
3.b	X			
3.c	X			
3.d	X			
3.e	X			
3.f	X			
3.g		X		
3.h		X		
3.i		X		
3.j		X		
3.k	X			
3.l		X		
3.m		X		
3.n	X			
3.o			Note 1	
3.p		X		
3.q		X		
3.r	X			
3.s			Note 2	
3.t				X
3.u	X			

1. Controlled plugging measures shall be provided so that if the operator reverses a drive while it is in motion, the torque during reverse shall be automatically controlled to a predetermined torque limit during deceleration.
2. The crane is designed to CMAA standards (i.e, a 5:1 minimum factor of safety for each component) for 15-ton lifts.

TABLE 9.1-3 (Continued)

FHB 15/2-TON CRANE – COMPLIANCE WITH REGULATORY GUIDE 1.104

Regulatory Position	STPEGS Complies with Rev. 0	STPEGS Meets the Intent of Rev. 0 and Complies with a Proposed Revision Dated January 1978	STPEGS Takes Exception to Rev. 0	Not Applicable by Either Rev. 0 or the Proposed Revision Dated January 1978
C.4.a	X			
4.b		X		
4.c	X			
4.d				X
C.5.a.c	X			
5.b	X			

TABLE 9.1-4

NSSS VENDOR RECOMMENDED SPECIFICATIONS AND GUIDELINES
FOR SPENT FUEL POOL WATER PURITY

Specification Parameters

Boric Acid, ppm B	≥2800[1]
Chloride, ppb	≤150
Fluoride, ppb	≤150

Guideline Parameters

pH @ 77°F	4.0 – 4.7
Aluminum, ppb	≤500
Calcium + Magnesium, ppb	≤500
Magnesium	≤250

[1] The 2800 ppm boric acid value for the spent fuel pool is an administrative practice to maintain compatibility with the boric acid requirements for refueling activities. The Technical Specification for spent fuel pool boron uses a value of greater than or equal to 2500 ppm to maintain margin to the criticality analysis for fuel storage. By maintaining the concentration at or above 2800 ppm, both spent fuel pool function (fuel storage) and refueling system interface requirements are satisfied. Refer to Section 9.1.3.1.3.

TABLE 9.1-5

SPENT FUEL POOL COOLING AND CLEAN-UP SYSTEM
FAILURE MODES AND EFFECTS ANALYSIS*

FAILURE MODES AND EFFECTS ANALYSIS

Description of Component	Safety Function	Plant Operating Mode**	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Safety Function Capability	General Remarks
SFP Cooling Pumps (Typical)	Circulate the water to the spent fuel pool	1 – 6	One pump fails to provide adequate flow	Status monitoring Temperature indication of SFP water	None – A redundant cooling train is available which will provide adequate cooling of the SFP	
Class 1E AC Power (Typical)	Provide 1E power to the pumps	1 – 6	Loss one train of power to its associated pump	Bus undervoltage alarms ESF status monitoring of pumps Pump status lights	None – A redundant power train exists to power the redundant pump	
Channel III DC Power (Train B)	Provide DC control power	1 – 6	Loss of DC power	ESF monitoring on UPS failure, DC trouble alarm ESF monitoring for pump (not running, no control power)	None – Redundant trains provide system capability	
Channel IV DC Power (Train C)	Provide DC control power	1 – 6	Loss of DC power	ESF monitoring on UPS failure DC trouble alarm ESF monitoring for pump (not running, no control power)	Non-Redundant trains provide system capability	

* Single failure only applies to normal modes of SFPCCS Operation.

** Plant Modes

1. Power Operation
2. Startup
3. Hot Standby
4. Hot Shutdown
5. Cold Shutdown
6. Refueling

TABLE 9.1-6

SPENT FUEL POOL BOILING

Parameters	
Core Thermal power, MWt	3,876
Decay assumed for the last full core offload	42 hours
Decay heat generator methodology	SRP 9.1.3
Volume of water in spent fuel pool, ft^3 (water at Technical Specification minimum elevation, 62' 0")	45,771.6
Dispersion Factors (χ/Q)	Table 15.B-1
Dose Conversion Factors	Based on ICRP-30 (see Table 15.B-3)
Dose Consequences	
Exclusion Zone Boundary (0-2 hours) Thyroid, rems	2.1×10^{-3}
Low Population Zone (0-30 days) Thyroid, rems	9.4

9.2 WATER SYSTEMS

9.2.1 Service Water Systems

South Texas Project Electric Generating Station (STPEGS) has two service water systems, the nonsafety-related Auxiliary Cooling Water System (ACWS) and the safety-related Essential Cooling Water System (ECWS). These systems are described in Sections 9.2.1.1 and 9.2.1.2, respectively.

9.2.1.1 Auxiliary Cooling Water System:

9.2.1.1.1 Design Bases: The ACWS is designed to provide cooling water from the Main Cooling Reservoir (MCR) to various nonsafety-related components in the Turbine Generator Building (TGB), including the nonsafety-related heating, ventilating, and air conditioning (HVAC) chillers, required turbine generator package coolers, steam generator feedwater pump turbine (SGFPT) lube oil coolers, and auxiliary cooling closed-loop saltwater/freshwater heat exchangers (HXs) which transfer the heat load from the auxiliary closed-loop coolers. The design of the auxiliary cooling water (ACW) piping is in accordance with the Power Piping Code of American National Standards Institute (ANSI) B31.1 and American Water Works Association (AWWA) C301, "Standards for Prestressed Concrete Pressure Pipe, Steel Cylinder Type, for Water and Other Liquids of the American Water Works Association". Miscellaneous equipment conforms to applicable standards of the Tubular Exchanger Manufacturer's Association (TEMA), National Electrical Manufacturer's Association (NEMA), American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (B&PV) Code, Hydraulic Institute (HI), and Steel Structures Painting Council (SSPC).

9.2.1.1.2 Design Description: The Open Loop ACW System flow diagram and the Closed Loop ACW System flow diagram are shown on Figure 9.2.1-1 and 9.2.1-2, respectively.

The ACWS consists of a closed (inhibited demineralized water) cooling loop and an open (brackish water) cooling loop. The closed cooling water loop services the turbine electrohydraulic control coolers, condensate pump motor coolers, feedwater (FW) booster pump lube oil coolers, startup steam generator (SG) FW pump lube oil cooler, hydrogen seal oil coolers (air and hydrogen side), exciter coolers, isolated phase bus coolers, stator winding liquid coolers, condenser vacuum pump coolers, secondary sample system coolers and chillers and instrument air compressors. The open cooling loop services the main turbine lube oil coolers, generator hydrogen coolers, SGFPT lube oil coolers, Mechanical Auxiliary Building (MAB) HVAC chillers, nonsafey-related Reactor Containment Fan Cooler (RCFC) chillers, auxiliary cooling saltwater/freshwater HXs, circulating water fill and circulating water priming pumps, and seal water system.

The closed Loop ACW System consists of three 50-percent-capacity, horizontal, split-case, electric-motor-driven closed loop ACW pumps. The design capacity of the Closed Loop ACW System is based on the total cooling water required for the serviced coolers at the maximum system water temperature of 105°F. The number of Closed Loop ACW pumps in operation at any given time is dependent on reservoir temperature and system heat loads. Cooling water from the closed-loop pump discharge header flows through the shell side of the two parallel 60-percent-capacity saltwater/freshwater HXs. The saltwater/freshwater HXs are TEMA-type CEN exchangers designed, constructed, and stamped in accordance with the ASME B&PV Code, Section VIII, Division 1. The cooling water combines into common header at the outlet of the saltwater/freshwater HXs and feeds the serviced coolers of the closed loop system, as shown on Figure 9.2.1-2. Cooling water discharging from the serviced coolers is combined into a common header to the closed-loop pump suction header, completing the closed loop. A closed loop cooling water surge tank fabricated and stamped in accordance with the requirements of the ASME B&PV Code, Section VIII, Division 1 is provided primarily to supply net positive suction head (NPSH) control for the closed-loop pumps and to allow for thermal expansion. In addition, the closed loop is filled and makeup is provided by the demineralized water storage system, as discussed in Section 9.2.6, through the closed-loop surge tank. Corrosion inhibitor may be added to the closed-loop system through the ACW chemical addition tank, which is designed, constructed, and stamped in accordance with the ASME B&PV Code, Section VIII, Division 1. Other chemicals (e.g., pH modifiers or biocides) may be added as prescribed in good industry practices.

The Open-Loop ACW System consists of three 50-percent-capacity, vertical, turbine-type, electric-motor-driven open-loop ACW pumps, of which two are used in normal operation and one in standby. These pumps take suction from the auxiliary bay of the Circulating Water Intake Structure (CWIS) (see Section 10.4.5 for CWIS description) and discharge into a common header through a duplex, basket-type strainer to the tube side of the nonsafety-related RCFC HVAC chillers, MAB HVAC chillers, generator hydrogen coolers, main turbine lube oil coolers, SGFPT lube oil coolers, and the tube side of the ACW saltwater/freshwater HXs. The heated cooling water from the HXs flows back to the MCR (see Section 2.4.8 for the design of the MCR) via the Circulating Water System (CWS) return piping (see Section 10.4.5 for system description). The materials used for Open Loop ACW Subsystem piping include cement-lined and neoprene-lined carbon steel, stainless steel, aluminum bronze, copper, and other corrosion-resistant materials. The materials used for miscellaneous equipment include nitronic stainless steel shafts and couplings with Ni-Resist open-loop pump columns(1), titanium tubes, and aluminum bronze-clad channels for the system HXs (except for the MAB HVAC chillers and the nonsafety-related RCFC chillers), and Ni-Resist for the open -loop duplex strainers. These materials were selected to minimize corrosion in the open-loop brackish water.

9.2.1.1.3 Safety Evaluation: The ACWS is a non-nuclear safety (NNS) class system. It is not safety-related.

Since the ACWS serves no components which could potentially contain radioactive fluids, no radiation detectors are required. No safety evaluation is required for the ACWS.

9.2.1.1.4 Tests and Inspections: The system is hydrostatically tested before service. Components are functionally tested before startup and periodically tested thereafter. Data is taken periodically during normal plant operation to confirm heat transfer capability. This is a nonsafety-related operation to confirm heat transfer capability. This is a nonsafety-related system; therefore, there are no inservice testing requirements.

[1] Open-Loop ACW System pump columns made of carbon-steel have been approved by STP.

CN-3081

9.2.1.1.5 Instrumentation Application: Local controls are provided for all pumps and pneumatically operated valves to manually operate the system during testing and startup operations. Remote controls are provided in the control room for the operating the open and closed-loop ACW pumps in the manual or automatic mode during all phases of plant operation from startup to full power. Automatic controls are provided to operate the ACWS during all phases of turbine plant operation, without operator assistance. The backup open-loop and closed-loop pumps start automatically on low heat pressure or on an automatic trip of an operating pump. A screen wash control system is provided to automatically start and stop or wash the traveling screens of the auxiliary bay of the CWIS, as discussed in Section 10.4.5.

Automatic temperature control systems are provided on the following coolers to maintain the temperature of the cooled medium within set limits:

1. Turbine generator (TG) lube oil coolers

2. Turbine electrohydraulic control fluid coolers

3. Generator hydrogen coolers

4. Stator winding liquid coolers

5. Exciter coolers

6. Hydrogen seal oil coolers

7. SGFPT lube oil coolers

An automatic level control system maintains a minimum water level in the closed-loop surge tank by controlling makeup water flow to the surge tank.

On-off manual control is provided for the MAB chillers and nonsafety-related RCFC chillers and on-off automatic control is provided for the instrument air compressors to supply cooling water only when the equipment is in operation. The rest of the coolers receive cooling water continuously. Cooling water to the turbine lube oil coolers and SGFPT lube oil coolers is manually provided (through manual valves) when the equipment is in operation, automatic temperature control is then provided as described above.

Local indicators are located throughout the ACWS to monitor the process parameters.

Remote indications of the following process parameters are displayed in the control room on panel indicators and/or the plant computer:

1. Closed loop ACW pump discharge header pressure and temperature

2. Open loop ACW pump discharge header pressure and temperature

3. ACW pump side screen well level

4. Intake structure reservoir level

5. Flows and temperatures for turbine lube oil coolers, generator hydrogen coolers, SGFPT lube oil coolers, ACW saltwater/freshwater HXs, MAB and nonsafety-related RCFC HVAC chillers combined outlet, turbine elctrohydraulic control coolers, and the combined flow from the hydrogen seal oil coolers, exciter coolers, phase bus coolers, and stator winding liquid coolers.

   Various alarms are indicated in the control room on a visual annunciator or on the plant computer display. These alarms warn the operator of abnormal system conditions so that corrective action can be taken.

Pressure safety valves are provided throughout the ACWS to protect all coolers, HXs, and pressure vessels from overpressurization.

9.2.1.2 Essential Cooling Water System:

9.2.1.2.1 Design Bases: The ECWS is designed to supply cooling water to various safety-related systems for normal plant operation as well as normal shutdown and during and after postulated Design Basis Accidents (DBAs).

The required cooling water is taken from the Essential Cooling Pond (ECP) which is the ultimate heat sink, designed in accordance with Regulatory Guide (RG) 1.27 (Section 9.2.5). The ECP is shared between Unit 1 and Unit 2.

The ECP contains a water supply for a minimum of 30 days of heat removal without outside makeup with a Loss-of-Coolant Accident (LOCA) in one unit and safe shutdown in the other. The ECWS is designed to operate with the ECP at its lowest expected level during this period.

The ECWS is designed to:

1. Remove heat from plant equipment required for safe shutdown or design basis LOCA conditions. This equipment includes:

   a. Component cooling water (CCW) HXs

   b. Diesel generator (DG) HXs

   c. Essential chiller condensers

   d. CCW pump supplementary coolers

2. Remove heat from certain plant equipment during normal operation. This equipment includes:

   a. CCW HXs

   b. Essential chiller condensers

   c. CCW pump supplementary coolers

3. Perform its cooling function following a DBA with either offsite or onsite power available, automatically and without operator action, assuming a single failure.

4. Meet seismic Category I, safety class (SC) 3 requirements.

5. Permit periodic inspection and functional testing of all components to assure the integrity and operability of the system.

6. Meet NPSH requirements of the ECWS pumps.

9.2.1.2.2 System Description: The ECWS (see Figures 9.2.1-3 and 9.2.1-4) is designed, in conjunction with the Component Cooling Water System (CCWS), to supply adequate cooling to accommodate the various modes of plant operation. The various heat loads for any of the modes will be dissipated in the ECP, which is the ultimate heat sink (Section 9.2.5), by three cooling loops. A separate and independent ECWS is provided for each unit of the STPEGS.

Heat rejection to the ECWS during either normal operation, normal shutdown, or DBA conditions is accomplished by three redundant cooling water loops, each having its own pump, motor, self-cleaning strainer, piping, valves, and instrumentation. Each loop contains one set of DG HXs, one CCW HX, one essential chiller condenser, and one CCW pump supplementary cooler. Cooling water is supplied to each of these components during all modes of operation, whether or not the particular equipment is operating. An essential cooling water (ECW) loop is required to operate whenever its corresponding CCW loop is in operation (Section 9.2.2). The normal operation of each ECW pump and associated components is rotated to monitor operational capability and balance operating time.

A traveling water screen is provided upstream of each ECW pump in the ECW Intake Structure (ECWIS) to minimize debris entering the ECWS which could cause damage to the pumps or could clog HX tubes. Trash bars are located in the intake (upstream of the traveling water screens) to protect the screens and pumps from debris. The head terminals of the traveling water screens are located on an operating deck which is above the maximum flood level in a missile-proof compartment over the pump bays. Screen wash booster pumps, which take suction from the ECW pump discharge piping, provide water to wash each traveling water screen.

The ECW pumps, traveling water screens, strainers, and valves are located in the seismic Category I intake structure at the ECP (see the general arrangement drawing listed as Figure 1.2-49 in Table 1.2-1). The pumps take suction from a sump in the ECP so that during periods of low water in the ECP, minimum NPSH requirements of the pumps can be met (Section 9.2.5.2).

The structure is subcompartmentalized such that the equipment of each ECW loop is separated from that of the other loops by walls that are flood-proof. A watertight door for each compartment is located on the west side of the structure (Section 3.4.1.1). Vents for each compartment are located above the maximum flood level on the structure. The vents are protected from missiles by an overhanging wall of the intake structure. The pump seals to the intake structure floor are watertight so that no water will leak into the compartments during flood conditions. ECW pump suction bells are located in a sump. The bottom of the sump is at E1. 10 ft. A minimum submergence of 10 ft is provided for these pumps to have adequate submergence to prevent vortices and to meet NPSH requirements.

The switchgear for the ECWIS is located in the Electrical Auxiliary Building (EAB). Train-oriented 480 V motor control centers (MCCs) and lighting panels are located in the ECWIS.

The ECWS and ECWIS are protected from missiles in accordance with the criteria in Section 3.5.

A seismic Category I discharge structure is located at the ECP. Each return line enters the structure underground and then discharges into the ECP from above grade.

See Section 3.8.4 for more information on the intake and discharge structures. The seismic category, safety class, and applicable industry codes for the equipment located at the ECWIS are given in Section 3.2. Component design data are found in Table 9.2.1-1. The maximum allowable ECP water temperature during normal operation is defined by the Technical Specifications. Section 9.2.5 describes the ultimate heat sink.

The following is a description of the ECWS during major modes of operation.

9.2.1.2.2.1 <u>Normal Operation Mode</u>: The normal operating mode is two independent ECW trains. The CCW HX, essential chiller condensers, and CCW pump supplementary cooler all reject heat to the ECWS during normal operation. The maximum instantaneous heat load for this mode is approximately 81 x 10^6 Btu/hr.

9.2.1.2.2.2 <u>Normal Unit Shutdown Mode</u>: For normal shutdown of the unit, three ECW loops may initially be used to provide the CCW HXs, essential chiller condensers, and CCW pump supplementary coolers with the cooling capacity required to meet the maximum design cooldown rate. Maximum instantaneous heat rejected to the ECWS during this mode is approximately 378 x 10^6 Btu/hr.

The unit can be shut down, cooled down, and maintained in the cold shutdown mode with only two ECWS loops in operation.

9.2.1.2.2.3 <u>Operation Mode During and After a DBA</u>: All three ECWS loops are designed to operate initially to provide cooling for equipment required to mitigate the consequences of a DBA. There is sufficient Engineered Safety Features (ESF) equipment and cooling for mitigating the consequences of a DBA after a single failure in the ECWS. Those pieces of equipment rejecting heat to the ECWS during this mode are:

1. CCW HXs

2. Essential chiller condensers

3. CCW pump supplementary coolers

4. DG HXs

A minimum of two ECW trains is required to operate following a DBA. The maximum instantaneous heat rejected to the ECWS during the design basis LOCA is shown in Table 9.2.5-2.

9.2.1.2.2.4 Low Temperature (Winter) Operation Mode: During "cold ECW" conditions, the manual valves downstream of the Essential Chillers are closed and the manual bypass valves are throttled to maintain ECW flow. Refer to section 9.4.1 for additional information.

9.2.1.2.3 Safety Evaluation: The ECWS provides a reliable source of cooling water for plant auxiliaries which are essential to a safe shutdown or for mitigating the consequences of postulated DBAs. The ECWS is designed to seismic Category I, SC 3 requirements and is capable of meeting the system design basis assuming either a single active or passive failure. A single-failure analysis of the ECWS is given in Table 9.2.1-2.

Redundant pumps, pump motors, strainers, valves, valve operators, and instruments inside the intake structure are physically separated from each other by reinforced concrete walls that are designed to preclude coincident damage to redundant equipment from equipment failure or missiles.

In the event of loss of offsite power (LOOP), power to the ECW pumps is supplied by the ESF buses, which is supplied by the DGs (Section 8.3). Each Class 1E ESF bus provides electrical power to its respective ECWS cooling loop. The only mechanical crosstie between cooling loops is between the essential chiller condensers of each loop.

The entire system is adequately protected to withstand adverse environmental occurrences such as postulated earthquakes, tornadoes, and tornado-generated missiles. Each subsystem of the ECWS is physically separated and protected to the extent necessary to assure safe shutdown for any one of the following events:

1. Pipe whip and jet forces resulting from high-energy pipe rupture

2. Tornado missile

3. Flooding or steam release from equipment failure such as pipe or tank rupture

4. Safe Shutdown Earthquake (SSE)

5. Fire

6. Tornado winds

7. Floods

The cooling water used in the ECWS is taken from the ECP. The plant fresh water supply system (well water) is used to provide makeup to the ECP. The plant freshwater supply system derives its flow from three on-site wells. As described below, evaluation of ECP water quality conservatively assumed the MCR to be a potential makeup source and sized the blowdown system accordingly. These evaluations (described below) remain valid and bounding because well water has superior quality to MCR water.

Water from the MCR has been evaluated for its scale-forming and corrosive tendencies. The corrosive or scale-forming tendencies of water may be theoretically determined utilizing the Langelier index method. In this method, the actual pH of the water is compared with the saturation pH of the water. The saturation pH of water is determined by standard formulae based on the total dissolved solids, temperature, calcium hardness, and alkalinity of the water. If a saturation pH value is greater than actual pH, a tendency towards corrosion is indicated. Alternatively, scale-forming tendencies are indicated when the saturation pH is less than the actual pH of the water. Table 9.2.1-3 shows an evaluation of the corrosive and scale-forming tendencies of the ECP.

Water samples from the Colorado River were found to exhibit varying tendencies toward slightly to moderately scale-forming, depending on the flow rate of the river and the time of the year. In usual practice, treatment is required when the difference in actual and saturation pH values exceeds unity.

To prevent biological fouling, a biocide treatment is implemented using an intermittent injection upstream of the ECW pumps.

All components of the ECWS, except underground piping and portions of the traveling water screen header, are housed within temperature-controlled areas. The underground piping is buried at a depth sufficient to protect the lines from freezing and other adverse environmental conditions. The exposed portion of the traveling water screen header has a weep hole to drain the pipe when not in use.

The ECWS does not cool any system which normally contains radioactive coolant. The only system served by the ECWS which could potentially contain radioactivity is the CCWS. The CCWS has a radiation monitoring system to alert the operator of any leakage of radioactivity into the system. In order for leakage of radioactivity to escape to the ECWS, a concurrent tube leak in a CCW HX would be required. One of the CCWS functions is to provide an intermediate barrier to prevent the uncontrolled leakage of radioactivity to the environment. With the small amount of CCWS-to-ECWS leakage which may be tolerated for system operation and the high flow rates in the ECWS, radiation detectors in the ECWS would serve no useful function because of detector sensitivity limitations. Instead, a radiation monitoring system is provided in the CCWS to detect leakage past the first barrier.

CN-3078

Most ECWS piping is fabricated from aluminum-bronze and some welds that use backing rings have shown a susceptibility to cracking. The potential effects of cracking in the above ground and below ground ECWS piping have been evaluated considering the potential for cracking, flooding, spray, and undetected failure. Based on the ability to detect the cracking before it reaches a critical size, it has been concluded that the ECWS capability to mitigate the effects of an accident is not significantly affected. A more detailed description is provided in Appendix 9A.

Part of the backwash line of the self-cleaning strainer which discharges to the ECW discharge structure is non-Seismic and not safety class. A rupture in the portion of the line, following a DBE can result in uncontrolled release of water from the ECP. This could result in failure of the ECP and ECW systems to perform the safety function of providing cooling water for up to 30 days following a DBE. Quality Class 3, seismic Category I backwash lines to the ECWIS have been provided to serve as emergency backwash lines. If the ECP level cannot be maintained above the minimum normal level, operator action is required within 24 hours to open the emergency backwash line valve and close the normal backwash valve.

9.2.1.2.4 Tests and Inspections: The ECWS was tested in accordance with Chapter 14 requirements. System surveillance requirements are discussed in the Technical Specifications.

Periodic inspections of the ECWS are conducted to detect leakage that might indicate the presence of cracking. The above ground portion of the ECW System is visually inspected. The below ground portion of the ECW system is monitored by performing walkdowns of the yard area above the buried ECWS piping to identify unusual water or moisture accumulation that might indicate leakage beneath the surface. These inspections are described in Appendix 9A.

9.2.1.2.5 Instrument Application: Actuation of the ECWS is discussed in Section 7.3. Control switches are provided for manually starting or stopping each ECW pump from the control room. Upon a LOOP or actuation of a safety injection (SI) signal, all three ECW pumps are automatically started by the ESF load sequencers. During normal operation, the standby ECW pump (s) and its associated CCW train are started automatically due to low header pressure in either the CCWS or ECWS. Upon actuation of an SI signal, the ECW blowdown isolation valves are automatically closed.

An alarm for high ECW self-cleaning strainer differential pressure is provided in the control room. The ECW pumps with product lubricated bearings do not have lube water strainer differential pressure alarms. CN-3080

A control system is provided to automatically start and stop the traveling screens during normal operation. A high differential water level sensed across any traveling screen alarms in the control room and automatically starts the screen wash booster pump and, after reaching adequate screen wash pressure, starts the traveling screen. The screen wash valve is opened whenever the booster pump is running. The traveling screens and booster pumps are automatically activated on receipt of an SI signal. However, because there is no design basis accident which would require a SI to occur concurrent with a condition requiring the screen wash system, this actuation is not a design basis function and is not required for operability.

ECW pump discharge pressure and ECWS inlet and outlet water temperatures are monitored remotely. Local pressure, differential pressure, and temperature indicators are provided to monitor the parameters of the ECWS.

Thermal relief valves are provided at the ECWS inlet or outlet nozzle on each HX to prevent overpressurization in the event ECW flow is blocked when the HX is in service.

Table 9.2.1-4 lists those relief valves in the ECWS for which Code Case N-242 is permitted. This Code Case provides alternate rules which may be used for the acceptance of metallic materials which were not manufactured or supplied in complete conformance with the rules of NCA-3800 (or NA 3700) and which are used in the construction of items for which the applicable code is Winter 1973 Addendum or later. The valves are listed by tag number.

9.2.2 Component Cooling Water System

9.2.2.1 Design Bases: The CCWS meets the requirements of 10CFR50, Appendix A, General Design Criteria (GDC) 1, 2, 3, 4, 5, 44, 45, 46, 54, 56 and 57. STPEGS Units 1 and 2 have separate but identical CCWSs.

The CCWS is designed to:

1. Provide cooling water to various nuclear plant components during all modes of plant operation. This includes plant equipment required for safe shutdown and ESF equipment required after a postulated DBA.

2. Provide an intermediate fluid barrier between potentially radioactive systems and the ECWS to reduce the possibility of leakage of radioactive contamination to the outside environment.

3. Perform its cooling function following a DBA with offsite or standby power sources, automatically and without operator action, assuming a single active or passive failure.

4. Provide cooling water at 60°F to 105°F temperature during normal operation. The maximum temperature during DBA is 122.9°F (refer to Section 9.2.5.3.3).

5. Conform to seismic Category I requirements and safety classifications as indicated on Figures 9.2.2-1 through 9.2.2-5 and in Table 3.2.A-1.

6. Permit periodic inspection of important components and periodic and functional testing to assure the integrity and operability of the system. See Sections 3.9.6 and 6.6.

In addition, the CCWS is protected from the effects of tornado loadings, missiles, flooding, pipe whip, and jet forces from pipe breaks. See Sections 3.3.2, 3.4.1, 3.5,and 3.6.

9.2.2.2 System Description:

9.2.2.2.1 Description: The CCWS consists of three separate redundant trains, each with a pump, HX, associated piping, and valves, that service two RCFCs, Residual Heat Removal (RHR) HX, and RHR pump, as shown on Figures 9.2.2-1 through 9.2.2-3. The three trains are connected to a common header which services other equipment as shown in Figures 9.2.2-4 and 9.2.2-5. In addition, a compartmentalized surge tank is used to accommodate the water thermal expansion and contraction.

A CCW HX bypass line is provided to maintain 60°F minimum CCWS temperature.

For heat removal following a DBA, all three CCWS trains will operate if available, but two trains are capable of performing the heat removal function. Except for the seal water HX, reactor coolant pump (RCP) lube oil coolers and thermal barrier, RCP motor air coolers, RHR pump seal coolers, centrifugal charging pump (CCP) supplementary coolers, CCP lube oil coolers, and positive displacement pump supplementary cooler, the remaining equipment is isolated by valves which close on an SI signal. Flow to the RCP lube oil coolers, thermal barrier, and motor air coolers is automatically isolated upon reaching the Containment pressure HI-3 setpoint. An SI signal opens the pneumatic valve (closed during normal operation) to provide cooling water to each RHR HX. Also, an SI signal shifts the cooling water supply to the RCFCs from the chilled water system to the CCWS by closing the chilled water and opening the CCWS motor operated supply and return valves.

Cooling water to the spent fuel pool (SFP) HXs is manually restored within 2.5 hours following the SI-induced isolation.

Upon a LOOP signal, the RCB chilled water supply and return valves are closed automatically. The CCWS motor-operated valves to and from the RCFC remain closed. Operator action from the main control room is required to restore flow to the RCFCs within 30 minutes after LOOP.

The following components are cooled by the CCWS:

1. ESF Loads

    a. RHR HXs

    b. RCFCs

2. Non-ESF Loads

    a. RCPs – lube oil coolers and thermal barrier

    b. RCP motor air coolers

    c. RHR pumps – seal coolers

    d. Centrifugal charging pumps (CCPs) – lube oil coolers

    e. Excess letdown HX

    f. Reactor coolant drain tank (RCDT) HX

    g. Seal water HX

    h. Boron Recycle System (BRS) recycle evaporator package

    i. Boron Thermal Regeneration System (BTRS) chiller unit

    j. Post-accident sampling system (PASS) sample coolers, primary sampling coolers, boric acid sample coolers, and radiation monitor sample coolers

    k. Liquid Waste Processing System (LWPS) evaporator package

    l. SFP HXs

    m. Letdown HX

    n. CCP supplementary coolers

o. Positive displacement pump supplementary cooler.

The maximum heat loads and required flow rates for each component during the different modes of operation are listed in Table 9.2.2-4.

Each CCW HX is designed to meet the normal operational heat loads. The design maximum CCW outlet temperature from the CCW HX is 105°F. During normal operation, one CCW pump, one compartment of the CCW surge tank, one ECWS pump, and one CCW HX are in use to provide a source of cooling water. The system has sufficient capacity to meet the required heat removal rates for the remaining operating conditions such as startup, shutdown, and recirculation.

The CCWS is required to remove residual and sensible heat from the Reactor Coolant System (RCS) through the RHR HXs from approximately 4 hours after normal shutdown (when the RHR HXs are placed in service) until the reactor coolant temperature reaches 150°F. Operation of the system is then continued in order to maintain cold shutdown. The CCW flow from each RHR HX is indicated on the main control board and displayed through the QDPS. The position of each CCW block valve in the outlet line of each RHR HX is monitored by open/close indicating lights on the main control board and by the ESF Status Monitoring System. Since the RHR HX does not need to function until after recirculation switchover is completed, following a design basis LOCA, the operator would have sufficient time to open the CCW block valve by using the manual switch in the control room, if the SI signal failed to actuate the valve. If this attempt to open the block valve fails, the corresponding SI train should be shut down and the core cooling requirement will be provided from the two remaining SI trains. The affected CCW train should also be shut down because of flow considerations (minimum pump flow). The normal cooldown heat load is removed by all three CCW pumps and HXs. If one of the three trains is inoperative, the cooldown function is still effective, although the cooldown period is extended beyond the three train cooldown time of 12 hours. However, this does not affect the safe shutdown and cooldown of the reactor.

Pumps, safety-related valves, and instrumentation required to operate each CCW train are provided with power from their respective standby power sources if normal and offsite power fail. Two of the three cooling trains are available within 60 seconds for a safe shutdown and cooldown of the reactor in case of a LOOP and a simultaneous failure of one standby power source.

Each CCW pump is connected to a separate ESF bus which is powered from either offsite or standby power sources. The pump control logic provides for automatic starting of the standby pump(s) in the event of low system pressure or low ECW pressure during normal operation.

The CCW surge tank is partitioned into three equal volumes by internal baffles. Each compartment is connected to the inlet piping of one of the CCW pumps. The surge tank is sized to accommodate the water thermal expansion and contraction and the inleakage or outleakage in the system until the leaking component is isolated. The internal baffles are designed to provide separation between redundant CCW trains, so excess leakage from a pipe break in one train does not affect the operability of the other trains. The surge tank is located at the highest point in the system in ensure the required NPSH for proper operation of the CCW pumps and to provide a path for collecting entrapped gases. A radiation monitor activates an alarm if the CCW radioactivity increases beyond a preset level (see Section 11.5) due to inleakage from systems being cooled. Makeup to the CCWS is added automatically from the Demineralized Water System (DWS). Low surge tank level initiates makeup; high surge tank level terminates makeup. As a backup by manual valve alignment, makeup water can be obtained from the Reactor Makeup Water System (RMWS) which is a safety-related and seismic Category I makeup source. A high-high surge tank level alarms in the control room. An alarm is also indicated in the control room if the level in the surge tank continues to decrease due to inadequate makeup. Further decrease in the surge tank level closes the valves on the lines to some non-ESF equipment (BTRS chiller unit, LWPS evaporator package, sample coolers, radiation monitor sample coolers, letdown HX, excess letdown HX, BRS evaporator package, and RCDT HX).

If the level in the surge tank continues to decrease, each CCW train is automatically isolated from the other trains by closing the motor-operated supply and return valves located upstream and downstream of the common supply and the return headers, respectively. Simultaneously, the pneumatic crossconnect valves (FV-4656 and FV-4657) in the CCP and positive displacement pump coolers supply and return headers (CCW train A and CCW train B from CCW train C) and motor-operated valves MOV-0768 and MOV-0772 are closed to prevent loss of more than one CCW train at a time. As soon as the CCW common header is isolated, the low pressure switch located in the common header will automatically start the standby CCW pump (s).

CCW supply to the RCPs is terminated as a result of the isolation of the CCW common header. However, the seal water to the RCPs from the CCPs is maintained since CCW supply to the CCP lube oil coolers is not isolated. Should the water level fall below the top of the surge tank dividing baffles, an alarm is indicated in the control room. Low-low surge tank compartment level initiates another alarm in the control room. The operator may trip the pump to respond to these alarms.

Self-actuated, spring-loaded relief valves are provided for lines and components which could be pressurized beyond their design pressure due to improper operation or failure of the physical barrier separating the CCW from other high-pressure systems.

The system, except for NNS portions, is designed to seismic Category I requirements and is located inside seismic Category I structures. A failure in the NNS portion would not affect the operation of the remainder of the system since low (makeup inadequate) surge tank level isolates the NNS section. The system equipment and piping are classified as SC 2 and 3 and NNS, as shown on Figures 9.2.2-1 through 9.2.2-5. The codes and standards to which the system is designed are listed in Table 3.2.A-1.

The water chemistry program for the Component Cooling Water System is based on good industry practices. Demineralized water is used for makeup. Specifications are established for pH, chloride, and fluoride. The corrosion inhibitor concentration is maintained in accordance with the manufacturer's recommendations.

9.2.2.2.2 Components:

1. Heat Exchangers

The CCW HXs are of the shell and straight tube type. The ECW circulates through the tubes while CCW circulates through the shell. Titanium tubes are used to provide maximum corrosion resistance to the brackish ECW. The shell is carbon steel. Design parameters are listed in Table 9.2.2-1.

2. Pumps

The CCW pumps are motor-driven horizontal, double-suction, dual-volute centrifugal pumps with antifriction bearings. Design parameters are listed in Table 9.2.2-1.

3. Surge Tank

The CCW surge tank is constructed of carbon steel. The tank is partitioned to form three separate volumes in the lower portion of the tank. The upper portion of the tank is open to each compartment. Design parameters are listed in Table 9.2.2-1.

4. Chemical Addition Tank

The chemical addition tank is a vertical cylindrical tank constructed of carbon steel. Its design parameters are given in Table 9.2.2-1.

5. Valves

The valves used in the CCWS are constructed of carbon steel. Self-actuated, spring-loaded relief valves are provided for lines and components which might be pressurized beyond their design pressure by improper operation or malfunction. Table 9.2.2-5 lists those relief valves in the CCWS for which Code Case N-242-1 is permitted. This Code Case provides alternate rules which may be used for the acceptance of metallic materials which were not manufactured or supplied in complete conformance with the rules of NCA-3800 (or NA-3700) and which are used in the construction of items for which the applicable code is Winter 1973 Addendum or later. The valves are listed by tag number.

6. Piping

All CCW piping is carbon steel with welded joint end connections, except at components which might be removed for maintenance. In this case, flanged connections are used.

9.2.2.3 <u>Safety Evaluation</u>

9.2.2.3.1 <u>Availability and Reliability</u>: The normal operation of each CCW pump and HX train is rotated to monitor operational capability and balance operating time.

The operability of safety-related valves and equipment, as required during various modes of operation of the system, is tested by simulated signals corresponding to each mode on a routine basis.

The CCWS performs vital cooling functions during and after a postulated DBA, and therefore is designed to meet the single-failure criterion. Sufficient cooling capacity is provided to fulfill all system requirements under accident conditions, assuming a single failure in the CCWS.

To meet the ESF cooling requirements, the CCW pumps are automatically sequenced on standby power in the event of a LOOP. The electric power supplies to the pumps, valves, instrumentation, and control cabling for each cooling train are physically separated. Power is supplied to each pump from an independent ESF bus.

The CCW pumps, HXs, SC 2 and 3 valves, and piping are designed to seismic Category I requirements and are located in seismic Category I structures. They are protected against internally generated missiles, pipe whip, jet forces, and flooding due to pipe rupture. The CCWS equipment is located in areas shielded from radiation and is accessible for maintenance or inspection during power operation.

A failure mode and effect analysis (FEMA) for the CCWS is given in Table 9.2.2-3.

The CCWS design incorporates automatic isolation of cooling water to the RCPs by the Containment isolation phase B signal. Loss of cooling water to the RCPs due to a spurious isolation signal or the operator closing a single isolation valve is avoided by parallel Containment isolation valves, as shown on Figure 9.2.2-5. The control logic for the valves is designed so that a spurious isolation signal in any one actuation train does not isolate flow; however, isolation is assumed on a penetration basis even assuming the single failure of one of the three actuation trains.

9.2.2.3.2 Leakage Minimization, Detection, and Isolation: To minimize the possibility of leakage, welded construction is used throughout the CCWS where practicable.

Makeup to the system is automatic. The surge tank level is monitored by the main plant computer and the QDPS. Opening of the valve providing tank makeup is alarmed by the computer to give an indication of system leakage. If the normal source of makeup (the DWS) fails or is inadequate, the surge tank level instrumentation provides alarms and actuations as discussed in Section 9.2.2.2.1.

Should a large inleakage into the CCWS develop, the level in the surge tank will rise, and the high-high-level condition will be annunciated. If a leaking fluid is radioactive, then a high radiation level will be alarmed. Refer to Section 11.5 for further information on the process radiation monitor. If the level in the surge tank continues to increase, the CCW will discharge to the CCW sump through the open vent. The vent is designed to accommodate the maximum inleakage due to the rupture of one RCP thermal barrier, which is estimated at 275 gal/min. The increased pressure due to a rupture of the RCP thermal barrier will close two active self-actuated pressure regulated valves located at the CCW outlet from the RCP thermal barrier and isolate the RCS inleakage. In addition, a high flow or high temperature in the return line from the thermal barrier, indicating failure of the RCP thermal barrier pressure-retaining boundary, will close the CCW motor-operated valve downstream of the two pressure regulated valves; and alarm in the control room alerts the operator as well. The portion isolated is designed for RCS pressure and temperature.

The operator, by checking flow and temperature readings against normal values, can locate the affected portion of the system and isolate this portion by closing the appropriate remotely operated or manual valves. Very small leaks will be detected by periodic inspection of the system piping and valves.

The relief valves on the CCW lines to the various HXs are sized to relieve the volumetric expansion occurring if the shell side of the HX is isolated and high-temperature process fluid flows through the HX tubes.

9.2.2.3.3 CCW Maintenance That Secures Cooling to SFP Heat Exchangers:

When maintenance is performed on the CCW system, cooling to the spent fuel pool (SFP) heat exchangers may be secured for an extended period. For the SFP, the water temperature limit is 150.7°F (UFSAR Table 9.1-1). The CCW maintenance outage is performed such that the SFP licensing basis temperature limit of 150.7°F is not exceeded.

Prior to performing a CCW outage that secures cooling to the SFP heat exchangers, an evaluation is performed to ensure the spent fuel pool will not exceed the licensing basis temperature limit. The evaluation considers:

- time to complete the maintenance evolution with SFP cooling secured
- initial SFP water temperature
- SFP heatup rate from Plant Curve

During the maintenance period, either the SFP TROUBLE alarm is set to ensure that the appropriate temperature limits are not exceeded based on the calculated SFP cooling restoration time and heatup rate, or temporary logs are kept. The temporary logs are taken a regular intervals to monitor the actual SFP water temperature and heatup rate.

9.2.2.4 Tests and Inspections: During preoperational testing, the following will be checked:

1. Calibration of all instrumentation

2. Actuation of automatic controls at their proper setpoints

3. Actuation of alarms at the setpoints

4. Operation of power-operated valves

5. Operation of CCW pumps and checking of flow and discharge pressure

6. Checking and adjusting required flow to each component serviced by CCWS

7. System water chemistry

All the above functions are checked periodically during the life of the plant.

Inservice inspections of ASME B&PV Code, Section III, Class 2 and 3 components are performed in accordance with ASME B&PV Code, Section XI.

9.2.2.5 Instrumentation Application: The Engineered Safety Features Actuation System (ESFAS) for the CCWS is discussed in Section 7.3.1. Controls for remote manual operation of each CCW pump and selection of standby CCW pumps are provided in the control room. Remote manual control of pneumatically operated valves under normal operating conditions is provided in the control room. Pneumatically operated valves are not required for control purposes and fail in the safe position on LOOP. Remote manual control of all motor-operated and solenoid-operated valves necessary for post-LOCA cooling, for surge tank makeup, for maintenance of the CCWS trains, and for Containment isolation is provided in the control room. CCW pump operating status and valve position indicating lights are provided in the control room. Provisions are made for local indication and control in the switchgear room for each CCW pump and selected valves in the CCWS.

Selected maintenance isolation valves are provided with Power Lockout. To ensure that no spurious movement of these valves can occur, the power for these valves is locked out either from a control switch located at the main control panel or from the motor control center (MCC) breaker. For the valves with a power lockout control switch, indication is provided at the main control panel to monitor the position of the power lockout breakers for each valve: red (power on) and green (power off). Redundant valve position indication for these valves is also provided at the main control panel to supplement the normal valve position indicators when the power lockout is in operation. These redundant valve position indicating lights are powered independently of the valve operator control power. For the valves that are locked out from the MCC breaker, the MCC breaker must be closed locally to enable the valve to function remotely from the control room. For these valves, the indicating lights at the control panel are not illuminated when the MCC breaker is open. Backup indication on the main control panel is provided for these valves via the bypass/inoperable indicators. The bypass/inoperable indications are powered independently of the valve operator control power.

The temperature in each CCW main loop is monitored by the QDPS. The temperature at each CCW pump discharge is also monitored by the plant computer. The CCW return temperatures from all equipment are monitored through the plant computer except for the sample coolers, boron recycle evaporator, positive displacement pump supplementary cooler, CCP lube oil coolers, LWPS evaporator package, and CCP supplementary coolers. Temperatures for this equipment, with the exception of the sample coolers, are monitored locally.

Flows through the CCW main loops, RHR HXs, and RCFCs are displayed in the control room on panel indicators and logged by the QDPS while the remaining equipment, with exception of the letdown HX and sample coolers, has local flow indications or test connections. The temperature difference in conjunction with the flow data from individual components is used to monitor the particular component’s performance. Each CCW main loop outlet pressure is indicated in the control room through indicators and the QDPS. The radiation level in the CCWS is available in the control room through the Radiation Monitoring System (RMS) display.

Local pressure gauges are provided on the suction and discharge lines of each CCW pump. Local level gauges are provided for each compartment of the surge tank. Surge tank level indication is displayed in the control room through indicators and the QDPS. High and low levels in the surge tank are alarmed in the control room. Measurements taken downstream of each CCW HX, which indicates system malfunction, are annunciated in the control room. Local flow indication is provided on each RCP lube oil cooler and motor air cooler outlet. Low flow condition at each RCP lube oil cooler and motor air cooler outlet is annunciated in the control room.

9.2.3 Makeup Demineralized Water System

9.2.3.1 <u>Design Bases</u>: The Makeup Demineralized Water System (MDWS) uses sodium hypochlorite treated and filtered service water as influent and removes the ionic impurities of the raw water to provide high-purity demineralized water suitable for use in the primary and secondary cycles of the plant.

The purity of the water produced is suitable for preoperational tests, wet layup, startup, and normal operation of the plant primary and secondary systems. The system is designed for a specific nominal capacity, and transient demands for abnormal operating conditions are allowed for by the buffer effect of the storage volumes of the Demineralized Water Distribution System. For a more complete description of the Demineralized Water Distribution System and supply interfaces with other plant systems, refer to Sections 9.2.6 and 9.2.7 and Figures 9.2.6-1 , 9.2.6-2, and 9.2.7-1. The capability of the MDWS to store, handle, and dispense any chemicals used in the demineralization and regeneration process is described in Section 3.6 of the Environmental Report.

Piping, icon exchangers, and associated equipment of the MDWS are constructed of corrosion-resistant material or lined carbon steel to prevent contamination of the water by corrosion products. The equipment is designed in accordance with ASME B&PV Code, Section VIII, Division 1.

The MDWS is designed to produce demineralized water to meet NSSS vendor recommended guidelines as follows:

1. Specific Conductivity[(2)]	Less than 0.1 micro mhos/cm at 25°C
Oxygen	Less than 100 ppb
Suspended Solids[(3)]	Less than 50 ppb
Total Silica, SiO_2	Less than 50 ppb
Aluminum	Less than 20 ppb
Calcium	Less than 5 ppb
Magnesium	Less than 5 ppb
Total Organic Carbon	Less than 100 ppb
Active Silica	Less than 10 ppb

9.2.3.2 System Description: The MDWS piping and instrumentation diagrams (P&IDs) are shown on Figures 9.2.3-1 through 9.2.3-6.

Service water pumps supply sodium hypochlorite treated and filtered water from the service water storage tank to two cation softeners which reduce the total hardness of the influent. The softener effluent is filtered in the reverse osmosis 5 micron filter to remove residual suspended solids and chemically treated with sodium bisulphote for optimum reverse osmosis unit performance. The water leaving the cartridge filters is then boosted in pressure by the reverse osmosis feed pumps and processed through the reverse osmosis unit, where the bulk of the ionic impurities is removed. Two reverse osmosis units are provided. The pressure at the outlet of the reverse osmosis unit is sufficient to deliver the product water to the reverse osmosis product storage tank. The reverse osmosis product

[2] Specific conductivity of 0.1 micro mhos/cm limits halogen concentration to 12 ppb maximum.

[3] Suspended solids concentration determined by filtration through a 0.45 micron filter.

transfer pump delivers the water through the cation exchanger to the vacuum degasifier, wherein the carbon dioxide and oxygen are removed. The rejected brine gravity flows to the regenerant waste equalization basin in the nonradioactive chemical waste system. The vacuum degasifier transfer pumps take suction from the vacuum degasifier clearwell and pump the decationized water through the anion and mixed-bed exchanger to the demineralized water prover tanks. The quality of the demineralized water in each prover tank is verified by testing grab samples and by continuous onstream monitoring of the conductivity and dissolved oxygen, before and during transfer to the DWST.

Two demineralizer trains are provided, each comprised of a cation exchanger, and anion exchanger, and a mixed-bed exchanger. One vacuum degasifier is shared by both trains. The Makeup Demineralized Water System is designed to produce approximately 265 gal/min of demineralized water. The system is operated as necessary to meet the demineralized water requirements for the South Texas Project.

The regeneration wastes are carried by gravity to the makeup demineralizer regenerative waste equalization basin located just outside the Makeup Demineralizer Building. This basin has an effective capacity greater than one regeneration waste volume and is equipped with a discharge pumping system to pump the waste to the neutralization basin of the plant.

9.2.3.3 Safety Evaluation: The MDWS performs no safety-related functions. The system does, however, incorporate features which assure reliable operation over the full range of normal plant operations.

The MDWS neither contains, treats, nor produces radioactive materials. A check valve located in the inlet line to the reactor makeup water storage tank (RMWST) prevents any radiological contamination of the MDWS. No other sources of possible contamination are postulated. For additional discussion of this subject, refer to Section 9.2.7 for the RMWS and Section 9.2.6 for the condensate storage facilities.

9.2.3.4 Tests and Inspections: Components are inspected and cleaned before installation in the system. Piping and equipment are tested for both leakage and proper operation prior to being placed in service.

9.2.3.5 Instrumentation Application: The MDWS is controlled from local panels installed in the Makeup Demineralizer Building. Selected processes in some system components are automatic, with provisions for manual control. Critical points and processes throughout the entire system are automatically sequenced, monitored, verified, and alarmed.

Conductivity, silica, and sodium in the effluent from the demineralizer train are continuously monitored and recorded in the effluent from the demineralizer train. High conductivity and high silica concentrations are alarmed in the Makeup Demineralizer Building. A common “Makeup Demineralized Water System Trouble” alarm is provided in the main control room.

9.2.4 Potable and Sanitary Water System

9.2.4.1 Design Bases: The Potable and Sanitary Water System (PSWS) provides treated water in sufficient quantity and of sufficient pressure to satisfy applicable local, State and Federal requirements for human consumption and for the operation of plumbing fixtures for the personnel facilities of Units 1 and 2. The water source is ground wells.

Sanitary waste water from the discharge of plumbing fixtures is routed to the station's Sanitary Waste Treatment Systems, which are designed to produce the quality of effluent that satisfies, as a minimum, the applicable local, State, and Federal effluent discharge standards.

9.2.4.2 System Description:

The well water is chlorinated at the inlet line of the potable water storage tanks. The storage tanks are common to Units 1 and 2. Transfer pumps provide water to the distribution piping. Potable water is supplied to various buildings, both power block and non-power block facilities.

The Nuclear Training Facility, because of its remote location, has its own well and chlorination facility (shared with other remote facilities). The chlorination facility is designed to meet applicable local, State and Federal requirements for public water systems. Refer to Section 6.4.4.2 for the amount of chlorine handled at this location.

The wastes produced from potable and sanitary water usage are drained to the station's Sanitary Waste Treatment Plant facilities for processing prior to disposal. The station's Sanitary Waste Treatment System facilities are extended aeration activation sludge plants.

The digested sludge is collected by a licensed contractor and disposed of onsite or offsite in accordance with applicable local, State, and Federal environmental regulations. Sludge containing trace quantities of radioactivity may be land applied onsite in accordance with applicable state regulations. Treated sewage plant water discharge piping is connected directly to the reservoir.

9.2.4.3 Safety Evaluation: The system is not safety-related and is not designed to seismic Category I requirements. The waste directed to the Sanitary Waste Treatment Plants may contain trace quantities of radioactive material. No releases to groundwater are anticipated.

9.2.4.4 Tests and Inspections: After installation of the system, each component is inspected, cleaned, and tested. The potable water system is tested in accordance with applicable local, State and Federal regulations. In addition, other tests may consist of pressurizing the system and inspecting for leaks, calibrating instruments, and checking the operability and limits of alarm/functions. Major components are accessible for routine inspection during operation.

9.2.5 Ultimate Heat Sink

9.2.5.1 Design Bases: The ultimate heat sink (UHS) provides a source of cooling water for the ECWS for safe shutdown or accident conditions and is the normal heat sink for primary plant auxiliaries.

The UHS is capable of providing sufficient cooling for 30 days in order to:

1. Permit simultaneous safe shutdown and cooldown of both units and maintain them in a safe shutdown condition

2. In the event of an accident in one unit, permit control of that accident safely and permit simultaneous safe shutdown and cooldown of the other unit and maintain it in s a safe shutdown condition

The following safety design bases have been considered in the design of the ECP and ECWS structures:

1. The most severe individual natural phenomena expected

2. Site-related events that have occurred or that may occur during the plant lifetime

3. A single failure of man-made structural features

The discussion of each event is presented in the following sections.

Table 9.2.5-4 lists the combinations of natural phenomena considered in the design of the ECP. Reasonably probable combinations of less severe phenomena and/or site related events judged to be insignificant when compared to the controlling events are not included in this table.

9.2.5.1.1 The Most Severe Individual Natural Phenomena: The most severe individual natural phenomena, including the SSE, design tornado, probable maximum hurricane, flood events, and drought events, are discussed individually as follows:

9.2.5.1.1.1 Safe Shutdown Earthquake: The SSE is the controlling seismic event. The ECW structures, dividing dike, south embankment, and 5:1 excavated slopes are designed to withstand an SSE. The embankment and dike sections, which are designed to withstand an SSE, are shown on Figure 9.2.5-1. The 5:1 side slope of the excavated portion of the ECP below E1. 26 ft is discussed in Section 2.5.5. The north embankment of the ECP, although not Seismic Category I, has the same cross section as the Seismic Category I embankment but uses soil-cement protection with a nominal thickness of 1 ft instead of concrete protection. Furthermore, all embankments and dikes are located 30 ft from the excavated portion of the ECP and they will not affect the stability analysis of the excavated slope.

The seismic design of the south ECP embankment is required in order to demonstrate that it will remain intact following an SSE and, hence, be available to resist the hydraulic forces caused by a postulated loss of the MCR embankment. Since the north ECP embankment is not required to resist the flood forces caused by a breach of the MCR embankment, it is not designed as a seismic Category I structure. However, it is designed to resist the hydraulic forces resulting from a breach of upstream dams in the Colorado River (Section 9.2.5.1.4).

Therefore, the ECP and related ECWS structures are capable of withstanding an SSE without failure or loss of safety-related functions.

9.2.5.1.1.2 Design Basis Tornado: The design basis tornado is the controlling event for wind loading and wind-generated missiles (the component parts to the ECP, including the ECW structures, are designed to withstand the effects of tornado winds and missiles defined in Sections 3.3 and 3.5 without failure or loss of safety-related functions). The ECP contains a surface area of 46.5

acres and a volume of approximately 112,000,000 gallons of water at E1. 25.5 ft. The loss of significant amounts of water due to a design basis tornado is not considered possible.

9.2.5.1.1.3 Probable Maximum Hurricane: As described in Sections 2.4 and 3.4, major natural phenomena are examined to determine the controlling phenomenon pertaining to water levels and wind-wave forces on plant structures, including the ECP, ECWS, and related components. The controlling hydrologic event is determined to be flooding caused by the failure of either the MCR embankment or upstream dams on the Colorado River (see Section 2.4.4). The controlling event for wind loading and protection against missiles is the design basis tornado. Therefore, the Probable Maximum Hurricane (PMH) is determined to be a lesser event and will not result in a failure of the ECP, ECWS, or their related components. (See Section 2.4.5 for a discussion of flooding and wind-wave forces generated by the PMH.)

9.2.5.1.1.4 Flood Events: The Colorado River Probable Maximum Flood (PMF) has been investigated. Compared to flood events resulting from failure of man-made structures considered in Section 9.2.5.1.4, the Colorado River PMF is not a controlling event.

9.2.5.1.1.5 Drought Events: The ECP is sized to remain operative during a drought event under both emergency and normal plant operation conditions. Makeup requirements for normal pond operation are based on a 20-year pond operations study covering the years 1961-1980 and including the June-July 1980 critical month for evaporation. Seepage of up to 1.2 cfs (540 gpm) was conservatively considered. Using these assumptions for seepage and evaporation, along with continuous blowdown of up to 350 gpm, it was established that 500 gal/min makeup available from onsite wells would need to be supplemented by makeup of up to 850 gpm from another source, i.e. the MCR. This was the basis for the original design, which had two 550 gpm makeup pumps at the CWIS to back up well water as an ECP makeup source.

Actual ECP blowdown and seepage during the first 20 years of plant operation proved to be much lower than anticipated in the design. Measurements taken in 1986, 1990, 1995, 2000 and 2005, as required by section 2.5.6.6.2.4, confirmed that the actual seepage rate was very low. In 1986, the pond losses were measured at 0.62 ft^3/sec total, of which only 0.26 ft^3/sec was seepage. The majority of the loss was evaporation. In 2000 and 2005, total losses (evaporation plus seepage) did not exceed 0.30 ft^3/sec, indicating that seepage was close to zero. As a result, MCR water was never used to provide makeup to the ECP. The makeup pumps were removed from the CWIS in 2009. The well water system is used to maintain pond level to provide at least a 30-day supply of cooling water in the ECP. Plant shutdown is initiated when the pond level falls below El. 25.5 ft.

The ECP storage requirements are sized in accordance with RG 1.27, Revisions 1 and 2 which require the pond to be sized for a 30-day supply of water based on the most critical meteorological combinations. The meteorological data resulting in maximum evaporative water losses and minimum water cooling are given in Section 2.3.1.2.8.

9.2.5.1.2 Site-Related Events: The effects of an explosion of a chemical truck located on nearby FM (farm-to-market road) 521 (see Section 2.2.3) and of a gas well explosion (Appendix 2.2.A) have been considered as site related events. These events are determined to be not applicable to the design of the ECP and ECWS.

9.2.5.1.3 Reasonably Probable Combinations of Lesser Events: Reasonably probable combinations of lesser events have been investigated. The ECP, ECWS, and component parts have been found capable of withstanding and remaining operational during these combinations of lesser events. Those events considered significant are shown in Table 9.2.5-4.

9.2.5.1.4 A Single Failure of Man-Made Structural Features: The following events are considered under this category:

1. MCR embankment breach

2. Failure of upstream dams on the Colorado River

3. Failure of the ECP north embankment

The ECP and ECW structures are designed to withstand these events and still remain functional.

9.2.5.1.4.1 Main Cooling Reservoir Embankment Breach: The MCR embankment breach is the controlling flood event for the ECWIS, the ECP embankment, and the dividing dike. These structures are designed to withstand the dynamic and hydrostatic forces caused by the flood wave propagating from the MCR embankment breach (Section 2.4.4). The ECP is calculated to be overtopped and is designed to withstand this overtopping for the duration of the postulated accident. The MCR is situated south of the ECP, and the outflow resulting from a breach of the MCR embankment would move from south to north. Since the ECW Discharge Structure is located north of the ECWIS (Figure 9.2.5-1), the heated effluent will be carried away from the ECWIS and no thermal short-circuiting will occur.

Should the north ECP embankment fail as a result of the MCR breach, the fill material included in the embankment would not be deposited in the ECP since the velocity vectors and resulting flow are directed in a northerly direction, thus causing any of the north embankment materials caught in suspension or as sediment transport to be carried away from the ECP.

9.2.5.1.4.2 Failure of Upstream Dams: The failure of upstream dams on the Colorado River does not control the design of the ECP or the ECWS structures.

Should the flood resulting from the failure of upstream dams occur simultaneously with failure of the north ECP embankment, the resulting sediment transport would be minimal because of the transport mechanism. The transport phenomenon would result from standing water in the plant area in combination with wave action. Since the north ECP embankment is located 30 ft from the excavated portion of the ECP, the breaking waves passing over the embankment would have a minimal transport capability. Subsequently, it is anticipated that no turbidity problems would result from the failure and transport of the north ECP embankment materials into the ECP. The ECW pumps are designed to operate during accident conditions with the turbidity levels expected in the pond due to this condition. The embankment, excavated slopes, dividing dike, and ECW components, by virtue of their design to withstand the breach of the MCR embankment, will also withstand the effects of these Colorado River flood events.

9.2.5.1.4.3 ECP North Embankment Failure: The north ECP embankment is designed to withstand the forces caused by wind-wave action and is protected from possible erosion due to wave overtopping by a 15-inch-thick, soil-cement-lined slope.

The failure of the ECP nonseismic north embankment could be postulated to occur in combination with either of two flooding conditions:

1. At a time simultaneous with the instantaneous removal of a length of MCR embankment, or

2. At a time simultaneous with the arrival of a peak discharge resulting from the failure of dams upstream on the Colorado River

These cases are discussed in Sections 9.2.5.1.4.1 and 9.2.5.1.4.2.

9.2.5.2 System Description: The ECP is a man-made excavated pond 9 ft deep with an 8-foot-high embankment completely surrounding its perimeter (see Figure 9.2.5-1). The pond has a surface area of 39.2 acres at E1. 17 ft and 46.5 acres at E1. 25.5 ft. Both the dividing dike and the southern embankment are seismic Category I in addition to being designed to withstand the effects of a breach in the MCR embankment (see Figure 9.2.5-1 for limits). The remaining portion of the northern embankment is designed to withstand the effects of the Colorado River dam failures. Design details of the ECP are discussed in Sections 2.5.5 and 2.5.6.

The normal operating elevation is between E1. 25.6 ft and E1. 26.0 ft. The minimum operating level is E1. 25.5 ft. The volume of the ECP is sized to have a 30-day water supply to support the safe shutdown of both units.

The makeup water to the ECP is provided from the onsite well system. Any one of three wells can be used for makeup since they are connected by a common header. Blowdown from the ECP via the ECWS waste sump to the reservoir is provided to limit the buildup of total dissolved solids (TDS).

The ECWIS and ECW Discharge Structure are designed to seismic Category I requirements to withstand the combinations of natural phenomena shown in Table 9.2.5-4.

9.2.5.3 Safety Evaluation: The ECP is a below-grade excavated pond. It does not rely on any dam, berm or other manmade structure susceptible to single failure to contain water. Thus, it meets the requirements specified in RG 1.27 to serve as a single source of cooling water. The ECP is sufficiently sized to accept plant-rejected heat under the most severe conditions, as specified in RG 1.27, Revision 1 and Revision 2. An initial heat load is placed on the ECP due to its use by both units during normal operation. The design of the ECP and its component parts, as previously discussed, is such as to preclude the failure and introduction into the pond of any of its component parts during either seismic or flood events.

The ECWIS and ECW Discharge Structure are designed so that failure of the MCR embankment will not affect the function of the structures (Section 2.4.4).

The pond is designed to prevent thermal short-circuiting in the ECP due to the flooding of the pond. The only event which might cause a sustained overtopping of the central dividing dike and subsequently cause a potential problem with thermal short-circuiting is the failure of the MCR embankment. The ECW Discharge Structure is located on the north side of the ECP dividing dike (Figure 9.2.5-1). If breach of the reservoir embankment occurred, the heated water being discharged from the ECW Discharge Structure would be carried away from the ECP by the flow of the breach. Subsequently, the failure of the MCR embankment will not cause thermal short-circuiting in the ECP.

The elevation of the crest of the ECP dividing dike is 38 ft mean sea level, which is 3.9 ft above the maximum still-water level calculated for the plant site area due to the Colorado River dam failures. Therefore, thermal short-circuiting in the ECP due to upstream dam failures is precluded since there will be no sustained overtopping (see Section 2.4.4).

The performance of the ECP has been evaluated using two computer programs, STPPOND and NUCONTEMP3 MOD3. STPPOND is the NUS cooling pond model integrated with a plant model (Reference 9.2.5-1). NUCONTEMP3 MOD3 is a modified version of CONTEMPT-PS/111 (Reference 9.2.5-2).

The controlling meteorological conditions used for assessing the water supply availability and thermal performance of the ECP are presented in Section 2.3.1.2.8.

Water availability and thermal performance analyses are based on response to two heat rejection scenarios:

Case 1 LOCA occurs in one unit; the other unit is safely shut down (SSD/LOCA)

Case 2 Two units are safely shut down (SSD/SSD).

For both cases, a LOOP is assumed to occur simultaneously.

9.2.5.3.1 ECP Heat Loads: The total heat loads rejected to the ECP from the safe shutdown unit and the LOCA unit are shown in Figures 9.2.5-2 and 9.2.5-3, respectively, along with integrated heat load curves. The total heat load includes residual decay heat, sensible heat, and heat rejection from station auxiliary systems. Heat load on the UHS from pump work is considered negligible. Tables 9.2.5-1 and 9.2.5-2 summarize the heat loads for the safe shutdown unit and LOCA unit, respectively. Figure 9.2.5-7 shows the combined heat load on the ECP for the SSD/LOCA scenario.

It is assumed that, although three cooling loops initially are available to reject heat to the ECP, two 50-percent trains will perform long-term cooling functions over the 30-day post-accident period.

Residual decay heat rejected to the ECP from one unit is shown in Figure 9.2.5-4. The fraction of core decay heat released per hour was calculated from Westinghouse-supplied data with an uncertainty factor of 1.1 applied to the data per Branch Technical Position ASB 9-2. In the analysis, the reactor output prior to shutdown was set at 3,876 MWt to account for the 2 percent calorimetric error in measurements.

Heat rejection from station auxiliary systems, including heat sources from diesels, EAB HVAC chillers, and CCW pump supplementary coolers, is shown in Figure 9.2.5-5.

Sensible heat removed through RHR HXs from the LOCA unit and the safe shutdown unit is shown in Figure 9.2.5-6.

The ECP heat loads discussed above are based on Spent Fuel Pool (SFP) heat loads which have since been revised to address 18 month fuel cycles. The new SFP loads are increased from what was used in the original analysis. However, the effect is small and the information in the Tables and Figures is still representative of the LOCA evaluation.

9.2.5.3.2 ECP Water Supply Availability: In accordance with RG 1.27, Revision 1 and Revision 2 the ECP is sized to provide operation for a minimum 30-day period without requiring makeup following a DBA.

The design basis meteorological record used for this purpose consisted of a 52 day period of record; an historical, 20-day initialization set preceding a 32-day maximum evaporation set comprised of the sequential hourly meteorology for June 19 through July 20, 1980. In accordance with RG 1.27, Revision 1 and Revision 2 the 52-day period corresponds to meteorological conditions resulting in maximum evaporation and drift loss. The 52-day period is considered conservative for this analysis.

The LOOP concurrent scenarios investigated all begin on the 21st day of the design basis meteorological record. The pond level is assumed to be at E1. 25.5 ft which is the minimum pond level allowed prior to plant shutdown.

The maximum consumptive use of water in the ECP as a result of Case 1 and Case 2 events is shown in Tables 9.2.5-3 and 9.2.5-3.1, respectively.

The minimum water level, E1. 21.5 ft, occurs for the safe shutdown of both units (Case 2) when based on the given design parameters.

If makeup to the ECP is needed after 30 days, it will be provided from the onsite freshwater well system. ECP operation can thus be extended indefinitely.

During normal operation, makeup from the onsite freshwater well system is used to offset losses from evaporation, seepage, and blowdown. Provisions are made so that the 30-day water supply from the ECP is not comprised due to ECWS pipe break.

The ECP water use discussed above is based on ECP heat loads which include Spent Fuel Pool (SFP) heat loads which have since been revised to address 18 month fuel cycles. The new SFP loads are increased from what was used in the original analysis. However, the effect is small and the information in the Tables is still representative of the LOCA evaluation.

9.2.5.3.3 ECP Thermal Performance: Three design basis meteorological records were used in the minimum cooling analysis. The first 20 days of each record contain meteorological data to initialize the ECP temperatures during normal operation heat loads and flow rates. Each 20-day initialization set historically precedes the critical period for minimum cooling and it therefore serves as a conservative basis for determining the maximum temperature which could exist in the ECP at the time of the accident. The critical time period for minimum cooling depends on whether the analyses follow the requirements of Revision 1 or Revision 2 of RG 1.27, although both periods occurred in August 1955.

A summary of ECP performance for Case 1 (SSD/LOCA) and Case 2 (SSD/SSD) is given in Table 9.2.5-5. Unlike the ECP water supply availability studies, determining the maximum ECW and CCW supply temperatures requires the initiating event to occur at different times on the 21st day of the design basis meteorological records.

The maximum CCW supply temperature occurring for the SSD/SSD scenario is 112.6°F and is based on the RG 1.27 Revision 2 meteorological data base. The CCW/ECW supply temperature response to the SSD/SSD scenario is shown in Figure 9.2.5-8.

The maximum CCW supply temperature occurring in the SSD unit during the SSD/LOCA scenario is 113.7°F. The CCW/ECW supply temperature response in the SSD unit is given in Figure 9.2.5-9. The maximum CCW supply temperature occurring in the LOCA unit during the SSD/LOCA scenario has increased from 120.5°F to 122.9°F as discussed below. The CCW/ECW supply temperature response in the LOCA unit is given in Figure 9.2.5-10. Both maximum CCW supply temperatures occurred with the RG 1.27 Revision 2 data base.

The ECP thermal performance discussed above is based on ECP heat loads which include Spent Fuel Pool (SFP) heat loads which have since been revised to address 18 month fuel cycles. The new SFP loads are increased from what was used in the original analysis. However, the effect is small and the information in the Tables and Figures is still representative of the LOCA evaluation. The maximum CCW supply temperature occurring in the LOCA unit during the SSD/LOCA scenario with the increased SFP load is 122.9°F which is still bounded by the profile used for the containment LOCA pressure/temperature analysis. In this analysis, the Reactor Containment Fan Coolers are the most temperature sensitive equipment cooled by CCW. The CCW supply temperature of 122.9°F is less than the design input value specified in Table 6.2A.1.1-5.

9.2.5.4 Tests and Inspections: An additional allowance for sediment deposition is provided for in the design of the UHS. A survey program is used to determine the rate of sediment buildup during the life of the plant. Sediment level was measured by soundings performed every year starting in year 1987 to year 1997 with subsequent surveys preformed in year 2002 and 2009. There has been no measurable accumulation of sediment. Based on the results of the previous soundings, the frequency has changed to not less than once every 10 years, starting in year 2009. In the event the rate of sediment accumulation in the pond is such that it appears the level of accumulation will exceed 5 percent of the impoundment volume during the life of the plant, the sediment will be removed before that allowable limit is reached.

9.2.5.5 Instrumentation Application: Water level is monitored at the ECP by means of a permanent "Staff Gage" submerged in the pond water. Remote indication of ECW temperature at the ECW pump discharge is provided in the control room. (See Section 9.2.1.2.5 for a discussion of the ECW instrumentation.)

9.2.6 Condensate Storage Facilities

9.2.6.1 Design Bases: The condensate storage facilities are designed to supply demineralized water makeup, condensate storage, and also surge capacity for secondary system inventory changes due to changing plant conditions. The demineralized water system is designed to function during normal conditions, including startup, cold shutdown, cooldown hot standby, normal plant operation, and refueling. The demineralized water makeup is supplied from the DWST to the following users:

1. Makeup for the auxiliary feedwater storage tanks (AFST) and the secondary makeup tank (SMT) of each unit

2. Sufficient water storage for the Auxiliary Steam System

3. Makeup for the RMWST of each unit

4. Makeup to the secondary system for chemical addition and to the MDWS

5. Makeup to the ACWS closed-loop surge tank and the Generator Stator Water Cooling System

6. Makeup to the DG cooling water

7. Water to the secondary sampling system

8. Flush water to all plant radiation monitors

9. Flush water for makeup demineralizer silica analyzer

10. Demineralized water to the following systems in the MEAB, the FHB, and RCB:

    a. The decontamination area in the MAB for decontamination of system components

    b. The cask decontamination area in the FHB

    c. The Spent Fuel Pool Cooling and Cleanup System (SFPCCS) for makeup to the fuel pool

    d. The BTRS chiller surge tank for makeup

    e. The CCWS surge tank for makeup

    f. The laundry for laundry and personnel decontamination use

    g. The LWPS for miscellaneous flushing and filling operations

    h. The demineralized water header in the RCB for flushing and decontamination use

    i. The LWPS seal water tank

    j. The cask handling area in the FHB

    k. The SWPS

    l. The Reactor Head Degassing System

m. The LWPS evaporator package

n. The MAB desuperheating station

o. The LWPS spent resin storage tank

p. The LWPS hot water heater

q. The boron concentrates measuring system

r. The RCB Chilled Water System Expansion Tank

s. The MAB Chilled Water System Expansion Tank

t. The TSC Chilled Water System Expansion Tank

u. The Essential Chilled Water System Expansion Tanks

v. The Boron Recycle System for recycle evaporate feed pump and radiation monitor flushing

w. The Primary Sampling System

x. The Post-Accident Sampling System

11. Service water as needed in the MEAB, FHB, and RCB

12. Demineralized water to laboratories in the MEAB, FHB, and TGB

13. The Steam Generator Blowdown System (SGBS) Mixed-Bed Demineralizers

9.2.6.2 System Description: The condensate storage facilities consist of the AFSTS, SMTs, the condenser makeup pumps, the DWST, the demineralized water transfer pumps, and related piping, as shown on Figures 9.2.6-1 and 9.2.6-2.

The DWST is an internally corrosion-resistant-coated, carbon steel tank of approximately 1,000,000-gallon-capacity. The DWST is fed by the MDWS. The demineralized water is delivered to the various receivers from the DWST by the demineralized water pumps.

Each SMT is a stainless steel 300,000-gallon-capacity tank.

The condenser makeup pumps are used to deliver makeup water from the SMT to the condenser hotwell. Condenser hotwell high-level dumping is done from the condensate pump discharge downstream of the condensate polisher to the SMT.

9.2.6.3 Safety Evaluation: The DWST and SMT are not safety-related and consequently are classified nonseismic and NNS.

The DWST and SMT are designed to the standard specification for steel tanks, standpipes, and reservoirs (AWWA-D100-73 and American Petroleum Institute [API]-650).

The materials of the system equipment and components are such that the water quality required by the various receivers is ensured.

It is not anticipated that any radioactive material will be present in the condensate storage facilities. Condensate in the condenser hotwells that does not contain radioactive material can be pumped to the SMT by two methods. It can be pumped by the hotwell dump pump to the SMT or discharged by the condensate pumps through the condensate polisher and then to the SMT. Radioactivity in the secondary system is discussed in Section 10.4.1.3.

9.2.6.4 Tests and Inspections: Prior to preoperational testing, each component is inspected, cleaned, and appropriate Phase I tests performed. A preoperational test is conducted with all equipment and controls operational to verify that the system performance and operation meet all design requirements.

9.2.6.5 Instrumentation Application: Local controls are provided for all pumps and pneumatic valves to operate the system manually during testing and system startup. Remote controls with status-indicating lights are provided in the Makeup Demineralizer Building for manual and automatic control of demineralized water storage system pumps and pneumatic valves. The condenser makeup pumps can be controlled from the main control room as well as locally.

Automatic level control is utilized to maintain the minimum operating storage capacity in the SMT. Level instrumentation on the SMT regulates a level-control valve to control the flow of demineralized water into the SMT.

A cation conductivity indicator in the Makeup Demineralizer Building displays demineralized water conductivity on a continuous basis.

Alarms indicating high and low DWST levels, and low SMT water levels, low demineralized water supply header pressure, and high demineralized water conductivity are provided in the Makeup Demineralizer Building.

Local level and pressure indicators are utilized to monitor the status and operation of the system.

9.2.7 Reactor Makeup Water System

The RMWS receives water from the DWST and provides high-purity water to reactor plant systems requiring a source of high-purity water. A separate identical system serves each unit.

9.2.7.1 Design Bases: The applicable design codes and standards are listed in Table 3.2.A-1. The design bases for the RMWS are:

1. To provide a source of high-purity water meeting chemical specifications for makeup to RCS during normal operation and to systems listed in item 2, below.

2. To provide reactor-grade water from the RMWST to the following system:

   a. The BRS evaporator for flushing after draining

   b. The BRS evaporator reagent tank for mixing chemicals

   c. The BRS condensate demineralizers for additional cleanup of makeup water as required

   d. The Chemical and Volume Control System (CVCS) boron blending "tee" for boration of water to fill or makeup to the refueling water storage tank and to provide makeup to the RCS through the volume control tank

   e. The CVCS boric acid batching tank for mixing boric acid solutions

   f. The SFPCCS as an alternate makeup source

   g. The pressurizer relief tank (PRT) for alternate cooling, and the reactor coolant pump standpipes in the RCB; and,

   h. The CCWS surge tank for alternate makeup

9.2.7.2 System Description:

9.2.7.2.1 General Description: The RMWS, shown in Figure 9.2.7-1, consists of one storage tank, two transfer pumps, and associated piping, valves, and instrumentation.

The RMWST is a vertical, austenitic stainless steel tank containing a flexible elastomeric diaphragm for Unit 1 and a polyvinyl chloride diaphragm for Unit 2. The diaphragm prevents absorption of air which would raise the dissolved oxygen content above that allowable for use as reactor makeup water. Overpressure/overflow protection for the RMWST is provided by a loop seal which drains to a sump. Reactor makeup water is supplied to the served equipment by one of two 100-percent pumps operating in parallel. Either pump alone can deliver enough water to systems requiring an assured source of makeup. Leakage from the system is controlled by the use of high-quality mechanical seals at pump shafts.

Design parameters of system components are listed in Table 9.2.7-1.

9.2.7.2.2 System Operation: Makeup water is intermittently supplied to the RMWST from the DWST and, if necessary, the BRS. Provisions are available to supply makeup from the LWPS; however, to minimize potential contamination of the RMWST, this source is not used during normal plant operation. When the RMWST reaches a low level, the inlet control valve from the DWST automatically opens to provide makeup. When the tank reaches a high level, the inlet control valve automatically closes.

The selected reactor makeup water pump normally operates upon receipt of a CVCS start signal. Makeup to the other systems listed in Section 9.2.7.1 is by manual operation from the control room. A recirculation line from the pump discharge to the RMWST is provided to maintain minimum flow requirements when the selected pump is in operation.

Periodic samples are taken to assure that the quality of the makeup water meets the chemical specifications for service in the RCS.

9.2.7.3 Safety Evaluation: The RMWS provides a backup source of makeup to the CCWS surge tank and the SFPCCS. Those portions of the system necessary to provide makeup are classified SC 3 and seismic Category I. Portions of lines penetrating the RCB are SC 2. The remainder of the system is classified NNS, and isolation valves are provided to prevent failures in the NNS portions of the system from interfering with the operation of the SC 2 and SC 3 portions. The RMWST and reactor makeup water (RMW) pumps are SC 3. The system is designed to eliminate the possibility of backflow from potentially contaminated water systems to the demineralized water transfer piping.

The pumps, piping, and valves in the system are of stainless steel construction to reduce corrosion product contamination in the system, and for compatibility with interfacing systems.

The RMWST is located in a compartment in the MAB (Section 1.2). To prevent flooding of area containing safety-related equipment, in the unlikely event of piping failure which cannot be isolated from the RMWST, the compartment is designed to contain the contents of the tank.

The effects of flooding inside the RMWST compartment have been evaluated and the resulting consequences of flooding the RMW pumps are acceptable. This is based on the CCWS having sufficient volume to allow continued CCW operation without makeup for a considerable length of time, the fact that any reduction in the SFP water inventory would be the result of evaporation and minor leakage (e.g., valve stems) and that the CVCS will still have an adequate water supply until the reactor can be brought to a shutdown condition. As stated in Section 9.1.3.2, borated water can be provided to the SFP by running a temporary line and demineralized water can be added to replace evaporative losses through a connection in the SFPCCS return header. Demineralized water, if available, can also be used as a makeup source to the CCW surge tank and BRS can be used as a backup water supply to the CVCS.

9.2.7.4 Tests and Inspections: The RMWS operability is demonstrated by its use during filling, preoperational tests, and during normal operation. Test include calibration of instruments, checking the operation of active devices, and verifying proper operation of safety-related equipment within the system.

Inservice inspections are to be performed in accordance with applicable codes.

9.2.7.5 Instrumentation Application: The instrumentation and controls for the RMWS are designed for manual and automatic addition of reactor makeup water to other system components.

Level instrumentation is provided for the RMWST to indicate tank level, provide the operating signals to the level control valve in the demineralized water line, provide high and low-level alarms, inhibit pump operation on low-low levels, and isolate the NNS portions of the system on low levels. The tank level is automatically controlled by a level control valve in the demineralized water line.

A high-high alarm is included to alert the operator to any malfunction of the level control valve and provide time for operator action to prevent overflowing the tank.

All alarms are indicated in the control room. Level indication is provided in the control room. Pressure indication is provided locally to monitor pump operation.

Local and remote controls are provided for the reactor makeup water pumps. Normal control is provided by the reactor operator in the control room. In the automatic control mode, the pumps automatically start upon receiving a signal from the CVCS. When the CVCS demand has been satisfied, as indicated by high volume control tank (VCT) level, the selected RMW pump is manually stopped in the control room.

9.2.7.6 Single-Failure Analysis: A single-failure analysis employing a FMEA methodology was conducted for the RMWS. Table 9.2.7-2 presents a summary of components included in the analysis. Data presented by the table demonstrates that the RMWS can sustain the failure of any single active component and still meet its safety requirement.

9.2.8 Fresh Water and Service Water Systems

The Fresh Water and Service Water Systems process onsite well water. The treated and filtered water is stored and distributed to various systems in each unit and common facilities.

9.2.8.1 Design Bases: The Fresh Water System is designed to remove suspended solids and to reduce the iron level in the well water. Sodium hypochlorite is injected into the well water to prevent the influx of corrosion-influencing bacteria from the well into the plant water systems. Polymer is added to the process to coagulate the ferric iron prior to filtering. The removal of ferric iron and other suspended solids in the water is accomplished by two pressure sand filters. The treated and filtered water is then transferred to the (a) service water storage tank, (b) fire protection water storage tanks, and (c) salt dissolvers to satisfy the fresh water demands of these systems. The Fresh Water System is designed so there are no connections with systems that might contain radioactivity.

The Service Water System utilizes treated and filtered water from the Fresh Water System and transfers this water to various users throughout the plant from the Service Water System storage tank. The primary use of service water is the MDWS.

9.2.8.2 System Description:

9.2.8.2.1 General: The Fresh Water and Service Water Systems are shown on Figures 9.2.8-1 and 9.2.8-2, respectively. Both systems are located in the common facilities and serve both units.

9.2.8.2.2 Fresh Water System: Well water received from the three onsite wells is injected with sodium hypochlorite at the well water settling basin. The settling basin is constructed below-grade from reinforced concrete in accordance with the American Concrete Institute (ACI) Building Code 318-1971. Chlorination of the well water is provided by two 100-percent-capacity diaphragm-type sodium hypochlorite pumps. The water is transferred from the settling basin to the two pressure sand filters and on to the water users by two 100-percent-capacity vertical turbine pumps at the settling basin outlet section. Injection of polymer to the water upstream of the filters is provided by two 100-percent-capacity polymer feed pumps. The two 50-percent-capacity pressure sand filters remove ferric iron and other suspended solids.

9.2.8.3 Service Water System: Treated and filtered well water is received and stored in the 90,000-gallon (useable volume) service water storage tank (SWST). The SWST is a cylindrical steel tank having a self-supporting dome roof with an internal liner. Three 50-percent-capacity horizontal centrifugal service water pumps transfer the water to the following users:

- The MDWS
- Hose connections located in the TGB Units 1 and 2, and throughout the yard areas for washdown
- Miscellaneous users throughout the plant for pump seals, bearing cooling, line flushing, etc.

9.2.8.3.1 Safety Evaluation: The Fresh Water and Service Water Systems have no safety function. Failure of the systems has no adverse effect on any safety-related system or components.

9.2.8.4 Tests and Inspections: After installation each component is inspected, cleaned, and tested. Testing consists of pressurizing the system, inspecting for leak, calibrating instruments, and checking the operability of system components.

9.2.8.5 Instrumentation Application: Local controls are provided for the fresh water pumps, service water pumps, sodium hypochlorite pumps, polymer feed pumps, pressure filters, and pneumatically operated level and pressure control valves to manually operate the systems during testing and startup operations. Automatic controls are also provided for the above equipment to operate the system during all phases of power plant operation without operator action.

Instrumentation is shown on Figures 9.2.8-1 and 9.2.8-2. Local instrumentation is installed throughout the systems to monitor process parameters. Additional remote indications are provided at the Demineralizer Building Panel for selected process variables.

Various alarms are indicated on the Demineralizer Building Panel to alert the operators of abnormal system conditions.

Pressure safety relief valves are provided for the sodium hypochlorite pumps, polymer feed pumps, and pressure filters to prevent overpressurization.

REFERENCES

Section 9.2:

9.2.5.1 STPPOND, a cooling pond model integrated with the STPEGS plant model, is documented under NUS Analysis File No. 8719-02.

9.2.5.2 NUCONTEMP3 MOD3, created January 1978 and documented under NUS Consulting Division Software I.D. No. 100225, is a modified version of CONTEMPT-PS/111.

TABLE 9.2.1-1

ESSENTIAL COOLING WATER SYSTEM
EQUIPMENT DATA

ECW Pumps	
Number (per loop)	One
Type	Vertical, motor-driven
Design pressure	120 psig
Design temperature	150°F
Design flow	19,280 gal/min 20,610 gal/min (max.)
Material	Aluminum bronze
Required submergence	7.0 ft over suction bowl lip
Strainers	
Number (per loop)	One
Type	Self-cleaning
Design pressure	120 psig
Design temperature	150°F
Design flow	19,280 gal/min 20,610 gal/min (max.)
Material	90-10 CuNi-clad on carbon steel
Piping	
Design pressure	120 psig (screen wash piping, 150 psig)
Design temperature	150°F
Material	Aluminum bronze and stainless steel

TABLE 9.2.1-1 (Continued)

ESSENTIAL COOLING WATER SYSTEM
EQUIPMENT DATA

Valves	
Design pressure	120 psig (screen wash valves, 150 psig)
Design temperature	150°F
Material	Aluminum bronze and Stainless Steel
Traveling Screens	
Number (per loop)	One
Screen width	6 ft
Design approach velocity	1 ft/sec
Design flow	19,280 gal/min 20,610 gal/min (max.)
Material	PVC-coated carbon steel or Stainless Steel
Screen Wash Booster Pumps	
Number (per loop)	One
Type	Horizontal, centrifugal motor-driven
Design pressure	150 psig
Design temperature	150°F
Design flow	176 gal/min
Material	Aluminum bronze

TABLE 9.2.1-2

ESSENTIAL COOLING WATER SYSTEM
FAILURE MODES AND EFFECTS ANALYSIS

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection+	Failure Effect on System Safety Function Capability	General Remarks
ECW Pump (typical) (normally energized)	Operate and provide cooling water	1-6	One pump fails to deliver adequate flow	Flow monitors Pump status lights	None - Redundant ECW 50% trains available to provide adequate cooling	
Pump Discharge Check Valve (EW 0079, 0042 or 0006)	Open and permit flow	1-6	One check valve fails to open	Flow monitors	None- Redundant ECW 50% trains available to provide adequate cooling	
Pump Discharge Valve (normally open) (MOV 0151, 0137 or 0121)	Open and permit flow	1-6	One valve fails to open or fails closed	Position indication Flow monitoring ESF status monitoring	None - Redundant ECW 50% trains available to provide adequate cooling	

* Plant Modes

1. Power Operation
2. Startup
3 Hot Standby
4. Hot Shutdown
5. Cold Shutdown
6. Refueling

\+ All detection is in the control room unless otherwise noted.

TABLE 9.2.1-2 (Continued)

ESSENTIAL COOLING WATER SYSTEM
FAILURE MODES AND EFFECTS ANALYSIS

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection+	Failure Effect on System Safety Function Capability	General Remarks
Blowdown Valve (normally open) (FV 6937, 6936, or 6935)	Isolate the Blowdown line	1-6	One valve fails to isolate	Position indication ESF status monitoring	None - Redundant ECW 50% trains available to provide adequate cooling	
ECW Screen Wash Booster Pump (typical)	Operate and provide water to the screen	1-6	One pump fails to provide adequate flow	Status indication ESF status monitoring	None - Redundant ECW 50% trains available to provide adequate cooling	

* Plant Modes

1. Power Operation
2. Startup
3 Hot Standby
4. Hot Shutdown
5. Cold Shutdown
6. Refueling

\+ All detection is in the control room unless otherwise noted.

TABLE 9.2.1-2 (Continued)

ESSENTIAL COOLING WATER SYSTEM
FAILURE MODES AND EFFECTS ANALYSIS

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection+	Failure Effect on System Safety Function Capability	General Remarks
ECW Screen Wash Check Valve (EW 0254, 0255, or 0253)	Open and allow flow	1-6	One check valve fails to allow adequate flow	Indirect indication by the local pressure indicator	None - Redundant ECW 50% trains available to provide adequate cooling	
ECW Screen Wash Pump Discharge Valve (FV 6934, 6924, or 6914)	Open and Allow flow	1-6	One valve fails to open	Position Indication ESF status monitoring	None - Redundant ECW 50% trains available to provide adequate cooling	
ECW Self-Cleaning Strainer (typical)	Operate and Clean the strainer	1-6	One fails to operate	Local differential pressure indicator Hi differential pressure alarm	None - Redundant ECW 50% trains available to provide adequate cooling	

* Plant Modes

1. Power Operation
2. Startup
3 Hot Standby
4. Hot Shutdown
5. Cold Shutdown
6. Refueling

\+ All detection is in the control room unless otherwise noted.

TABLE 9.2.1-2 (Continued)

ESSENTIAL COOLING WATER SYSTEM
FAILURE MODES AND EFFECTS ANALYSIS

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection+	Failure Effect on System Safety Function Capability	General Remarks
ECW Traveling Screen (typical)	Operate and allow the screen to be cleaned	1-6	One fails to operate	Traveling Screen level differential alarm Screen pumps sides lo and lo-lo water level alarm	None - Redundant ECW 50% trains available to provide adequate cooling	
Instrument Air	None	1-6	Instrument air is lost	Header pressure indication and alarm	None - Loss of instrument Air causes air operational components to go to their safety position	
DC Power Typical channel (I, III, IV)	Provide DC power	1-6	Lose one channel	DC trouble alarm ESF status monitoring	None - Redundant equipment is available via the other DC channels	
Class 1E AC Power (typical)	Provide power to the train-related equipment	1-6	Lose one bus of AC power	Bus undervoltage alarm ESF status monitoring	Non – Redundant power trains are available	

* Plant Modes

1. Power Operation
2. Startup
3 Hot Standby
4. Hot Shutdown
5. Cold Shutdown
6. Refueling

\+ All detection is in the control room unless otherwise noted.

TABLE 9.2.1-2 (Continued)

ESSENTIAL COOLING WATER SYSTEM
FAILURE MODES AND EFFECTS ANALYSIS

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection+	Failure Effect on System Safety Function Capability	General Remarks
ESF Actuation Train (typical)	Provide train related actuation signals	1-6	One train fails to send a signal	ESF status monitoring	None - Redundant actuation trains will provide signals to their respective equipment	
Air Inlet Check Valves EW1024 EW1026 EW1028	None	1-6	Loss of Valve Function 1) Failure to Open 2) Failure to Close	1) Observance of Water Hammer in the Piping System 2) Flooding in MAB Room 017#	1) and 2) None - Redundant ECW 50% Trains available to provide adequate cooling	# Flooding of MAB Room 017 addressed in FRA Calc. NC-9712 and Flooding Calc. NC-9703
Air Inlet Check Valves EW1007 EW1011 EW1015	None	1-6	Loss of Valve Function 1) Failure to Open 2) Failure to Close	1) Observance of Water Hammer in the Piping System 2) Flooding of a DGB bay detected by plant personnel*	1) and 2) None - Redundant ECW 50%Trains available to provide adequate cooling	# Flooding of a DGB bay addressed in flooding calc. MC-5044

* Plant Modes

1. Power Operation
2. Startup
3 Hot Standby
4. Hot Shutdown
5. Cold Shutdown
6. Refueling

\+ All detection is in the control room unless otherwise noted.

TABLE 9.2.1-3

EVALUATION OF CORROSIVE/SCALE-FORMING
TENDENCIES OF THE ESSENTIAL COOLING POND

Condition	pH	pHs**	pH-pHs	Tendency
Case I Average Predicted TDS Level ECP TDS = 1960 mg/l Mg = 315 ppm as $CaCo_3$ Ca = 320 ppm as $CaCo_3$ Alk* = 230 ppm as $CaCo_3$	8.7	6.9 @ 95°F	+1.8	Moderately Scale-forming
Case II Maximum Predicted TDS Level ECP TDS = 5370 mg/l Mg = 920 ppm as $CaCO_3$ Ca = 460 ppm as $CaCO_3$ Alk* = 195 ppm as $CaCO_3$	8.6	6.9 @ 95°F	+1.7	Moderately Scale-forming
Case III Average Predicted TDS Level Makeup to ECP Acid Treated ECP TDS = 1980 mg/l Mg = 315 ppm as $CaCO_3$ Ca = 320 ppm as $CaCO_3$ Alk* = 230 ppm as $CaCO_3$ (before acid addition) Alk* = 70 ppm as $CaCO_3$ (after acid addition)	7.9	7.4 @ 95°F	+0.5	Slight Scale

* HCO_3 + Alkalinity
** Determined from Langelier index method

TABLE 9.2.1-4

ECW RELIEF VALVES TO WHICH ASME
B&PV CODE CASE N-242-1 IS PERMITTED

Unit 1	Unit 2
N1EW-PSV-6856	N2EW-PSV-6856
N1EW-PSV-6866	N2EW-PSV-6866
N1EW-PSV-6876	N2EW-PSV-6876
N1EW-PSV-6853	N2EW-PSV-6853
N1EW-PSV-6863	N2EW-PSV-6863
N1EW-PSV-6873	N2EW-PSV-6873
N1EW-PSV-6854	N2EW-PSV-6854
N1EW-PSV-6864	N2EW-PSV-6864
N1EW-PSV-6874	N2EW-PSV-6874
N1EW-PSV-6855	N2EW-PSV-6855
N1EW-PSV-6865	N2EW-PSV-6865
N1EW-PSV-6875	N2EW-PSV-6875
N1EW-PSV-6904	N2EW-PSV-6904
N1EW-PSV-6905	N2EW-PSV-6905
N1EW-PSV-6906	N2EW-PSV-6906

TABLE 9.2.2-1

COMPONENT COOLING WATER SYSTEM
DESIGN PARAMETERS

CCW Heat Exchangers

Quantity		Three
Type		Shell and straight tube
Design heat transfer capacity		72×10^6 Btu/hr
	Shell	Tube
Design pressure	150 psig	150 psig
Design temperature	250°F	250°F
Design flowrate	7.035×10^6 lb/hr	7.5×10^6 lb/hr
Design outlet temperature	105°F	104.6°F
Design inlet temperature	115.23°F	95°F(1)
Fluid	CCW	ECW

CCW Pumps

Quantity	Three
Type	Horizontal centrifugal
Design pressure	150 psig
Design temperature	250°F
Design flow	15,109 gal/min
Design head	170 ft
Fluid	CCW

1. 95°F is the design ECW temperature during normal operation. The ECW pond temperature could increase as high as 98.8°F based upon the ECW transient analysis under adverse meteorological conditions. This value (98.8°F) has been used in the design basis analysis of the ultimate heat sink as the maximum temperature before the accident.

TABLE 9.2.2-1 (Continued)

COMPONENT COOLING WATER SYSTEM
DESIGN PARAMETERS

CCW Surge Tank

Quantity	One
Type	Horizontal with two internal baffles dividing the tank into three compartments
Design pressure: internal	25 psig
external	Atmospheric
Design temperature	250°F
Normal operating pressure	Atmospheric
Total volume	6,800 gal (nominal)
Fluid	CCW

CCW Chemical Addition Tank

Quantity	One
Type	Vertical
Design pressure: internal	150 psig
external	Atmospheric
Design temperature	250°F
Normal operating pressure	40 psig
Total volume	50 gal
Fluid	CCW

TABLE 9.2.2-1 (Continued)

COMPONENT COOLING WATER SYSTEM
DESIGN PARAMETERS

CCW Piping to and from Reactor Coolant Pump Thermal Barriers
(Including isolation and check valves)

Design pressure	2,485 psig
Design temperature	650°F

CCW Piping and Valves
(Except piping to and from RCP Thermal barriers)

Design pressure	150 psig
Design temperature	250°F

TABLE 9.2.2-3

COMPONENT COOLING WATER SYSTEM
FAILURE MODES AND EFFECTS ANALYSIS

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Safety Function Capability	General Remarks
CCW Pump (typical of 3 one is normally operating)	Provide flow	1-6	One pump fails to provide adequate flow	Pump discharge pressure Pump discharge flow ESF status monitoring	None - Two trains of CCW are still available	
Heat Exchanger Throttle Valves (MOV 0643, 0645, 0647) normally open	Open and provide flow	1-6	One valve fails closed	Position indication ESF status monitoring	None - Two trains of CCW are still available	
Heat Exchanger Bypass Valves (MOV 0642, 0644, 0646) normally closed	Close to prevent bypass	1-6	One valve fails to close	Position indication ESF status monitoring	None - Two trains of CCW are still available	

* Plant Modes

1. Power Operation
2. Startup
3. Hot Standby
4. Hot Shutdown
5. Cold Shutdown
6. Refueling

TABLE 9.2.2-3 (Continued)

COMPONENT COOLING WATER SYSTEM
FAILURE MODES AND EFFECTS ANALYSIS

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Safety Function Capability	General Remarks
RCB Supply and Return Isolation Valves (MOV 0057, 0069, 0136, 0148, 0197, 0210) normally closed	Open to provide flow	1-6	One valve fails open	Position indication ESF status monitoring	None - Two trains of CCW are still available	
	Close to isolate Containment	1-6	One valve fails open	Position indication ESF status monitoring	None - Another valve in series will provide isolation	
Chilled Water Supply and Return Valves (MOV 0059, 0070, 0137, 0149, 0199, 0209 and FV-0862, 0863, 0864) normally open	Close to isolate	1-6	One valve fails closed	Position indication ESF status monitoring	None - Two trains of CCW are still available Another valve in series will provide isolation	
RCB Isolation Check Valves (CC0058, CC0138, CC0198) normally open	Open to supply flow	1-6	One valve fails to open	Flow indication	None - Two trains of CCW are still available	
	Close to provide Containment isolation	1-6	One valve fails to isolate	None	None - Another valve in series will provide isolation	

* Plant Modes

1. Power Operation
2. Startup
3. Hot Standby
4. Hot Shutdown
5. Cold Shutdown
6. Refueling

TABLE 9.2.2-3 (Continued)

COMPONENT COOLING WATER SYSTEM
FAILURE MODES AND EFFECTS ANALYSIS

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Safety Function Capability	General Remarks
RCFC Inlet/Outlet Valves (MOV 0060, 0064, 0063, 0067, 0139, 0143, 0142, 0146, 0200, 0204, 0203, 0207) normally open	Open to provide flow	1-6	One valve fails closed	Position indication ESF status monitoring	None - Two trains of CCW are still available	
RCB Isolation Valves (MOV 0068, 0147, 0208) normally open	Open to provide flow	1-6	One valve fails closed	Position indication ESF status monitoring	None - Two CCW trains are still available	
	Close to isolate the Containment	1-6	One valve fails to close	Position indication ESF status monitoring	None - Another valve in series will provide isolation	
RCB Isolation Valves (MOV 0012, 0049, 0050, 00122, 0129, 0130, 0182, 0189, 0190) normally open	Isolate containment	1-6	One valve fails open	Position indication ESF status monitoring	None - Another valve in series will provide isolation	

* Plant Modes

1. Power Operation
2. Startup
3. Hot Standby
4. Hot Shutdown
5. Cold Shutdown
6. Refueling

TABLE 9.2.2-3 (Continued)

COMPONENT COOLING WATER SYSTEM
FAILURE MODES AND EFFECTS ANALYSIS

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Safety Function Capability	General Remarks
RCB Isolation Check Valves (CC0013, CC0123, CC0183	Isolate containment	1-6	One valve fails open	None	None - Another valve in series will provide isolation	
RHR Heat Exchanger Valves (FV4531, 4548, 4565) normally closed	Open to provide flow	1-6	One valve fails to open	Flow indication Position indication ESF status monitoring	None - Two trains of RHR are still available	
Radiation Monitor Valves (FV4526, 4524, 4525)	Isolate radiation monitor on loss of power or instrument air	1-6	One valve fails to close	Position indication	None - The water is routed back to the surge tank	

* Plant Modes

1. Power Operation
2. Startup
3. Hot Standby
4. Hot Shutdown
5. Cold Shutdown
6. Refueling

TABLE 9.2.2-3 (Continued)

COMPONENT COOLING WATER SYSTEM
FAILURE MODES AND EFFECTS ANALYSIS

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Safety Function Capability	General Remarks
Demineralized Water Makeup Valve (LV4501)	To close	1-6	Fails open	Position indication	None - a check valve in series with this valve will prevent back flow. The vent line will prevent overpressurization of the surge tank	
LSL 4507B LSH 4505	None	1-6	One fails to send a signal or sends an erroneous signal (Control of makeup valve LV 4501)	Level indication Valve position indication	None - Two trains of CCW are still available	Note: The surge tank is compartmentalized to where one train's loss of water will not affect the others

* Plant Modes

1. Power Operation
2. Startup
3. Hot Standby
4. Hot Shutdown
5. Cold Shutdown
6. Refueling

TABLE 9.2.2-3 (Continued)

COMPONENT COOLING WATER SYSTEM
FAILURE MODES AND EFFECTS ANALYSIS

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Safety Function Capability	General Remarks
LSL 4505D	None	1-6	One fails to send a signal or sends an erroneous signal	Level indication Valve position indication	None - Two trains of CCW are still available	
LSL 4507C, 4505B, 4503B	Isolate non-nuclear safety (NNS) loads	1-6	One fails to send a signal or sends an erroneous signal	Level indication Valve position indication	None - The redundant signals are sent to the second isolation valves installed in series to ensure isolation occurs	
LSL 4503C, 4507D, 4505C	Isolate the common supply and return header	1-6	Fails to send a signal	Level indication Valve position indication	Redundant signals are sent to redundant solenoids and MOVs to ensure separation occurs. Check valves are provided to prevent flow between trains. A postulated failure of LSL-4503C will disable the automatic isolation between Trains A & B; however, due to the single failure criterion specified in UFSAR section 3.6.1.1 item 6 & 7 and 4A369NQ1004, this postulated failure is not assumed.	

* Plant Modes

1. Power Operation
2. Startup
3. Hot Standby
4. Hot Shutdown
5. Cold Shutdown
6. Refueling

TABLE 9.2.2-3 (Continued)

COMPONENT COOLING WATER SYSTEM
FAILURE MODES AND EFFECTS ANALYSIS

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Safety Function Capability	General Remarks
LT 4504, 4506, 4508	Provide level indication	1-6	One channel fails	Low level alarms	None - Two trains of CCW are still available	
LSL 4503, 4507, 4505	None	1-6	Fails to alarm	Level indication	None - Two trains of CCW are still available	
LSL 4503A, 4505A, 4507A	None	1-6	Fails to send a signal or sends an erroneous signal	Level indication	None - Two trains of CCW are still available	
Supply and Return Header Check Valves (CC0315, 0313, 0311, 0051, 0131, 0191)	Close on reverse flow	1-6	One fails to close	None	None - Another valve in series will provide isolation	
	Open to provide flow	1-6	One fails to open	None	None - Two trains of CCW are still available	

* Plant Modes

1. Power Operation
2. Startup
3. Hot Standby
4. Hot Shutdown
5. Cold Shutdown
6. Refueling

TABLE 9.2.2-3 (Continued)

COMPONENT COOLING WATER SYSTEM
FAILURE MODES AND EFFECTS ANALYSIS

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Safety Function Capability	General Remarks
Supply and Return Header Isolation Valves (MOV 0316, 0314, 0312, 0052, 0132, 0192) normally open	Close to isolate headers	1-6	One fails to close	Position indication	None - Two trains of CCW are still available	
Spent Fuel Heat Exchanger Isolation Valves (MOV 0447,0032) normally open	Isolate flow	1-6	One valve fails to close	Local indication ESF status monitoring	None - The other valve in series will provide isolation	
RCP Thermal Barrier Return Valves (typical) (FV 4620, 4621, 4626, 4627, 4632, 4633, 4638, 4639)	Allow flow	1-6	One valve fails close	Local indicator Temperature	None - CVCS seal injection is still available to provide cooling	
	Isolate on high pressure	1-6	One valve fails to isolate	Local indicator Flow alarm Temperature	None - Redundant valve in series will isolate	

* Plant Modes

1. Power Operation
2. Startup
3. Hot Standby
4. Hot Shutdown
5. Cold Shutdown
6. Refueling

TABLE 9.2.2-3 (Continued)

COMPONENT COOLING WATER SYSTEM
FAILURE MODES AND EFFECTS ANALYSIS

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Safety Function Capability	General Remarks
Non-ESF Isolation Valves in the Supply Line (MOV 0235, 0236) normally open	Isolate (non-ESF components during SI signal)	1-6	One valve fails to close	Position Indication ESF status monitoring	None - Two valves in series for isolation are available	
Non-ESF Isolation Check Valves in the Return Lines (CC0764, 0765)	Close on reverse flow	1-6	One valve fails to close	None	None - Two valves in series are available to prevent reverse flow	
6 in. Individual CCW Supply and Return Isolation Valves (MOV 0771, 0770, 0772, 0768, 0774, 0775) one is normally open	Open and provide flow	1-6	One valve fails to open	Position indicating lights	None - Two remaining CCW trains are available for safe shutdown	

* Plant Modes

1. Power Operation
2. Startup
3. Hot Standby
4. Hot Shutdown
5. Cold Shutdown
6. Refueling

TABLE 9.2.2-3 (Continued)

COMPONENT COOLING WATER SYSTEM
FAILURE MODES AND EFFECTS ANALYSIS

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Safety Function Capability	General Remarks
6 in. Charging Pump Cross Connect Supply and Return Valves (FV4656 and FV4657) normally open	Close	1-6	Valve fails to open	Position indicating lights	None - Two remaining solenoids are available to ensure closure of the valve	
Post-Accident Sampling Isolation Supply Valves (FV4540, 4541) normally open	Close	1-6	One valve fails open	ESF status monitoring Position indication	None - Two valves in series for isolating the Post-Accident Sampling System	
Post-Accident Sampling Isolation Return Check Valves (CC0797, 0796)	Close on reverse flow	1-6	One valve fails open	None	None - Two check valves in series to isolate the Post-Accident Sampling System	

* Plant Modes

1. Power Operation
2. Startup
3. Hot Standby
4. Hot Shutdown
5. Cold Shutdown
6. Refueling

TABLE 9.2.2-3 (Continued)

COMPONENT COOLING WATER SYSTEM
FAILURE MODES AND EFFECTS ANALYSIS

Description Of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Safety Function Capability	General Remarks
RCB Isolation RCP CCW Supply (MOV 0318, 0291) normally open	Close to isolate Containment	1-6	One valve fails open	Position indicating lights ESF status monitoring	None - Two valves in series for isolation	
	Open to provide cooling flow	1-6	One valve fails closed	Position indicating lights	None - Two valves in parallel will ensure water is provided	
RCB Isolation Check Valve (CC0319)	Close on reverse flow	1-6	Valve fails open	None	None - Two valves in series (one outside the RCB)	
RCDT and Excess Letdown Heat Exchanger Isolation Valve (MOV 0297, 0392, 0393) normally open	Close – isolate non-ESF load	1-6	One valve fails open	ESF status monitoring Position indicating lights	None - Two valves in series	

* Plant Modes

1. Power Operation
2. Startup
3. Hot Standby
4. Hot Shutdown
5. Cold Shutdown
6. Refueling

TABLE 9.2.2-3 (Continued)

COMPONENT COOLING WATER SYSTEM
FAILURE MODES AND EFFECTS ANALYSIS

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Safety Function Capability	General Remarks
RCDT and Excess Letdown Heat Exchanger Check Valves (CC0540, CC0541, CC0763, CC0402)	Close on reverse flow	1-6	One valve fails open	None	None - Two check valves in series	
RCB Isolation Valves (MOV 0403, 0542, 0404 and pneumatic valve FV4493) normally open	Close (to isolate RCB)	1-6	One valve fails open	Position indicating lights ESF status monitoring	None - Three valves out of the four are adequate to isolate the RCB	
	Open to allow flow	1-6	One valve fails to open	Position indicating lights	None - Valves are in parallel to ensure flow	
CCW Supply Check Valves (CC0327, 0759, 0363, 0757, 0321, 0756, 0346, 0758) to RCP thermal barrier	Close (on reverse flow)	1-6	One valve fails to close	None	None - Two check valves in series	
	Remain open	1-6	One valve fails to open	None	None - Seal water to RCP is provided by the charging pump from the CVCS	Pressure integrity of the seal for RCP is maintained either by seal water from the CVCS or thermal barrier cooling of the RCP from CCW
CCW Return Valves (MOV-0339, -0374, -0390, -0356)	None (pressure boundary only)	1-6	Close	None 1E position indicating lights	None - Seal water to the RCP is provided by the charging pump from the CVCS	Pressure integrity of the seal for RCP is maintained either by seal water from the CVCS or thermal barrier cooling of the RCP from CCW cooling water.
			Open	None 1E position indicating lights	None - Pressure regulators in series will isolate flow	

* Plant Modes

1. Power Operation
2. Startup
3. Hot Standby
4. Hot Shutdown
5. Cold Shutdown
6. Refueling

TABLE 9.2.2-3 (Continued)

COMPONENT COOLING WATER SYSTEM
FAILURE MODES AND EFFECTS ANALYSIS

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Safety Function Capability	General Remarks
ESF Actuation System (Trains A, B, and C)	Provide actuation signal as required to safety-related components	1-6	One train fails to generate actuation or signal	Loss of power Actuation train in test is alarmed by ESF monitoring Individual bistables used to generate signals are individually provided with lights and computer inputs and, combined with other similar inputs, are alarmed on main control board	None - System safety function is assured by actuation of the two remaining trains	
Class 1E AC Power Trains A, B, & C	Provide power to safety related components	1-6	Loss of a power train	Bus undervoltage alarms ESF status monitoring for the diesel generator system ESF status monitoring for the affected system and AC components	None - Two remaining trains are available to provide safety capability	

* Plant Modes

1. Power Operation
2. Startup
3. Hot Standby
4. Hot Shutdown
5. Cold Shutdown
6. Refueling

TABLE 9.2.2-3 (Continued)

COMPONENT COOLING WATER SYSTEM
FAILURE MODES AND EFFECTS ANALYSIS

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Safety Function Capability	General Remarks
Channel 1 DC Power Train A	Provide DC power to channel I components	1-6	Loss of DC power	ESF monitoring on UPS failure DC trouble alarm ESF status	None - Redundant trains provide system safety capability	
Channel II DC Power	Provide DC power to channel II components	1-6	Loss of DC power	ESF monitoring on UPS failure DC trouble alarms	None - Redundant trains provide system safety capability	Channel II DC power is used for FY4493 (RCB isolation valve)
Channel III DC Power Train B	Provide DC power to channel III components	1-6	Loss of DC power	ESF monitoring on UPS failure DC trouble alarm ESF monitoring for pumps	None - Redundant trains provide system safety capability	
Channel IV DC Power Train C	Provide DC power to channel IV components	1-6	Loss of DC power	ESF monitoring on UPS failure DC trouble alarm ESF monitoring for pump	None - Redundant trains provide system safety capability	

* Plant Modes

1. Power Operation
2. Startup
3. Hot Standby
4. Hot Shutdown
5. Cold Shutdown
6. Refueling

TABLE 9.2.2-4
COMPONENT COOLING WATER REQUIREMENTS

TOTAL HEAT LOAD 10^6 BTU/HR

					LOCA		Design Flow Each Component (gal/min)
	Startup(1)	Normal(2)	Shutdown(3) @ 4 hrs	Shutdown(4) @ 12 hrs	Injection(5)	Recirculation(6)	
Excess Letdown HX	6.5	--	--	--	--	--	330
RCDT HX	2.24	2.24	2.24	2.24	--	--	226
Seal Water HX	2.4	2.4	2.4	2.4	1.4	1.4	372
BRS Recycle Evaporator Package	9.3	9.3	9.3	9.3	--	--	780
BTRS Chiller	--	4.5	--	--	--	--	1,000
Primary Sampler Coolers	0.103	0.103	0.103	0.103	--	--	28(7)
LWPS Evaporator Package	17.6	17.6	17.6	17.6	--	--	1,780
SFPCCS HX(9)	31.0	31.0	31.0	31.0	--	31.0	3,000
Letdown HX	33.5	20.0	11.6	6.2	--	--	2,083
CCP Supplementary Coolers	0.266	0.266	0.266	0.266	0.266	0.266	50
RHR HXs	27.0	--	296.7	118.2	See Note 8	230	4,900

1. Heat loads shared by two CCW trains.
2. These are the maximum heat loads for each piece of equipment. However, they are not all expected to occur at the same time.
3. Heat loads shown occur 4 hours from initiation of shutdown and are shared by three CCW trains.
4. Heat loads shown occur 12 hours from initiation of shutdown and are shared by three CCW trains.
5. Heat loads are maximum during injection phase with two CCW trains.
6. Heat load at time recirculation (minimum safeguard) starts with two CCW trains.
7. Total flow to the coolers.
8. Flow is established through HXs by SI signal; however, heat load is zero until recirculation is started.
9. Consists of the normal maximum spent fuel pool heat load, including a planned refueling outage.
10. CCW flow on an intermittent basis.

TABLE 9.2.2-4 (Continued)

COMPONENT COOLING WATER REQUIREMENTS

TOTAL HEAT LOAD 10^6 BTU/HR

					LOCA		
	Startup[1]	Normal[2]	Shutdown[3] @ 4 hrs	Shutdown[4] @ 12 hrs	Injection[5]	Recirculation[6]	Design Flow Each Component (gal/min)
RCFCs	-------------------serviced by Chilled Water System------------				380.4	179	1800
RCP Lube Oil Cooler and Thermal Barrier	5.2	5.2	1.3	-	5.2		216
RCP Motor Air Cooler	4.6	4.6	1.15	-	-		140
RHR Pumps	0.03	-	0.09	0.09	-	-	6
Centrifugal Charging Pumps: Lube Oil Cooler	0.087	0.174	0.174	0.174	0.174	0.174	55
Positive Displacement Pump Supplementary Cooler	0.037	0.037	0.037	0.037	0.037	0.037	16
Boric Acid Sample Cooler	0.019	0.019	0.019	0.019	-	-	14
Post-Accident Sample Cooler	0.134	0.134	0.134	0.134	-	(10)	10
Radiation Monitor Sample Coolers	0.103	0.103	0.103	0.103	-	-	12[7]

1. Heat loads shared by two CCW trains.
2. These are the maximum heat loads for each piece of equipment. However, they are not all expected to occur at the same time.
3. Heat loads shown occur 4 hours from initiation of shutdown and are shared by three CCW trains.
4. Heat loads shown occur 12 hours from initiation of shutdown and are shared by three CCW trains.
5. Heat loads are maximum during injection phase with two CCW trains.
6. Heat load at time recirculation (minimum safeguard) starts with two CCW trains.
7. Total flow to the coolers.
8. Flow is established through HXs by SI signal; however, heat load is zero until recirculation is started.
9. Maximum normal heat load set at 1/3 core refueling load at equilibrium conditions after 140 hours decay, 1/3 core refueling load to equilibrium conditions each year for seven years.
10. CCW flow on an intermittent basis.

TABLE 9.2.2-5

CCWS RELIEF VALVES TO WHICH ASME B&PV CODE CASE N-242-1 IS PERMITTED

Unit 1	Unit 2
N1CC-PSV-4511	N2CC-PSV-4511
N1CC-PSV-4516	N2CC-PSV-4516
N1CC-PSV-4521	N2CC-PSV-4521
N1CC-PSV-4492	N2CC-PSV-4492
N1CC-PSV-4640	N2CC-PSV-4640
N1CC-PSV-4620	N2CC-PSV-4620
N1CC-PSV-4626	N2CC-PSV-4626
N1CC-PSV-4632	N2CC-PSV-4632
N1CC-PSV-4638	N2CC-PSV-4638
N1CC-PSV-4618	N2CC-PSV-4618
N1CC-PSV-4624	N2CC-PSV-4624
N1CC-PSV-4630	N2CC-PSV-4630
N1CC-PSV-4636	N2CC-PSV-4636
N1CC-PSV-4616	N2CC-PSV-4616
N1CC-PSV-4622	N2CC-PSV-4622
N1CC-PSV-4628	N2CC-PSV-4628
N1CC-PSV-4634	N2CC-PSV-4634
N1CC-PSV-4645	N2CC-PSV-4645
N1CC-PSV-4645A	N2CC-PSV-4645A
N1CC-PSV-4646	N2CC-PSV-4646
N1CC-PSV-4646A	N2CC-PSV-4646A
N1CC-PSV-4647	N2CC-PSV-4647
N1CC-PSV-4647A	N2CC-PSV-4647A
N1CC-PSV-4648	N2CC-PSV-4648
N1CC-PSV-4648A	N2CC-PSV-4648A
N1CC-PSV-4613	N2CC-PSV-4613
N1CC-PSV-4599	N2CC-PSV-4599
N1CC-PSV-4597	N2CC-PSV-4597
N1CC-PSV-4586	N2CC-PSV-4586
N1CC-PSV-4588	N2CC-PSV-4588
N1CC-PSV-4584	N2CC-PSV-4584
N1CC-PSV-4580	N2CC-PSV-4580
N1CC-PSV-4582	N2CC-PSV-4582
N1CC-PSV-4610	N2CC-PSV-4610
N1CC-PSV-4612	N2CC-PSV-4612
N1CC-PSV-4533	N2CC-PSV-4533
N1CC-PSV-4550	N2CC-PSV-4550
N1CC-PSV-4567	N2CC-PSV-4567
N1CC-PSV-4532	N2CC-PSV-4532
N1CC-PSV-4549	N2CC-PSV-4549
N1CC-PSV-4566	N2CC-PSV-4566
N1CC-PSV-4537	N2CC-PSV-4537

TABLE 9.2.2-5 (Continued)

CCWS RELIEF VALVES TO WHICH ASME
B&PV CODE CASE N-242-1 IS PERMITTED

Unit 1	Unit 2
N1CC-PSV-4539	N2CC-PSV-4539
N1CC-PSV-4554	N2CC-PSV-4554
N1CC-PSV-4556	N2CC-PSV-4556
N1CC-PSV-4571	N2CC-PSV-4571
N1CC-PSV-4573	N2CC-PSV-4573
N1CC-PSV-4503	N2CC-PSV-4503
N1CC-PSV-4528	N2CC-PSV-4528
N1CC-PSV-4642	N2CC-PSV-4642
N1CC-PSV-4653	N2CC-PSV-4653
N1CC-PSV-4652	N2CC-PSV-4652
N1CC-PSV-4595	N2CC-PSV-4595
N1CC-PSV-4593	N2CC-PSV-4593
N1CC-PSV-4590	N2CC-PSV-4590

TABLE 9.2.5-1

MAXIMUM HEAT REJECTED TO THE ESSENTIAL COOLING WATER SYSTEM FOR THE SAFE SHUTDOWN UNIT

Equipment		Heat Rejected x 10^6 Btu/hr
CCW heat exchangers		185.49
CCW pump supplementary coolers		0.32
Electrical Auxiliary Building HVAC chiller condensers		11.7
Diesel generators		27.98
	Total	225.49
Time at peak		15 hours

TABLE 9.2.5-2

MAXIMUM HEAT REJECTED TO THE ESSENTIAL COOLING WATER SYSTEM FOR THE LOCA UNIT

Equipment	Heat Rejected x 10^6 Btu/hr
CCW heat exchangers	330.46
Diesel generators	27.98
Electrical Auxiliary Building HVAC chiller condensers	11.7
CCW pump supplementary coolers	0.32
Total	370.46
Time at peak	2 hours

TABLE 9.2.5-3

MAXIMUM CONSUMPTIVE USE OF WATER
IN THE ESSENTIAL COOLING POND FOR A
SAFE SHUTDOWN IN ONE UNIT AND LOCA IN THE OTHER UNIT [1]

(2 LOCA/2SSD) – Start Time = hr 0

Time After Shutdown (Months)	Instantaneous Heat Rate Rejection (MBtu/hr)	Total Accumulated Seepage Loss at 1.2 cfs (acre-ft)	Total Accumulated Loss[2] (acre-ft)	Volume Remaining[3] (acre-ft)	Water Level (ft)	Percentage Initial Volume of Water Lost
0.00	446.1	00.0	000.0	344.0	25.5	00.0
0.25	217.0	18.4	041.7	302.3	24.6	12.1
0.50	180.5	36.9	082.5	261.5	23.7	24.0
0.75	171.7	55.3	126.7	217.3	22.6	36.8
1.00	164.1	73.8	174.2	169.8	21.6	50.6

1. Loads taken on a single evaporative pond.
2. Includes evaporation and seepage.
3. Based on total volume 344.0 acre-ft (capacity of pond at Elevation 25.5) at time of shutdown. Initial surface area = 46.5 acres.

TABLE 9.2.5-3.1

MAXIMUM CONSUMPTIVE USE OF WATER
IN THE ESSENTIAL COOLING POND
FOR THE SAFE SHUTDOWN OF TWO UNITS [1]

(2SSD/2SSD) – Start Time = hr 0

Time After Shutdown (Months)	Instantaneous Heat Rate Rejection (MBtu/hr)	Total Accumulated Seepage Loss at 1.2 cfs (acre-ft)	Total Accumulated Loss[2] (acre-ft)	Volume Remaining[3] (acre-ft)	Water Level (ft)	Percentage Initial Volume of Water Lost
0.00	179.4	00.0	000.0	344.0	25.5	00.0
0.25	219.4	041.7	41.7	302.6	24.6	12.1
0.50	191.8	36.9	082.5	261.5	23.7	24.0
0.75	181.8	55.3	126.7	217.3	22.6	36.8
1.00	174.6	73.8	178.5	165.5	21.5	51.9

1. Loads taken on a single evaporative pond.
2. Includes evaporation and seepage.
3. Based on total volume 344.0 acre-ft (capacity of pond at Elevation 25.5) at time of shutdown. Initial surface area = 46.5 acres.

TABLE 9.2.5-4

COMBINATIONS OF PHENOMENA CONSIDERED IN THE DESIGN OF THE ULTIMATE HEAT SINK

	Water Level	Sustained Wind	Seismic
A.	PMF [1]	Nominal [2]	Zero
B.	Normal [7]	Zero	SSE[3]
C.	Normal	Tornado	Zero
D.	100-year [4]	PMH [5]	Zero
E.	Dam Failures [6]	Nominal	Zero
F.	MCR Breach	Zero	Zero

1. PMF; see Section 2.4.3
2. 50-mph (2 year recurrence) sustained overland wind adjusted for overwater smoothness effects (which is dependent upon fetch); see Section 2.4.3.6
3. 0.10g horizontal ground acceleration
4. 100-year precipitation in conjunction with the normal operating ECP water level
5. PMH; see Section 2.4.5
6. See Section 2.4.4
7. ECP at normal operating elevation and the Colorado River contained within its banks.

TABLE 9.2.5-5

SUMMARY OF ECP PERFORMANCE DURING MINIMUM COOLING

Scenario	Rev. 1 Data Base: Max Tecw °F	Rev. 1 Data Base: Max Tccw (°F) Unit 1	Rev. 1 Data Base: Max Tccw (°F) Unit 2
SSD (2)/SSD (2) Time of LOOP 2103[b]	105.1 (253) [a]	111.5 (15)	111.5 (15)
SSD (2)/LOCA (2) Time of LOOP 2102	104.8 (254)	112.6 (16)	116.5 (2)
SSD (2) LOCA (2) Time of LOOP 2116	104.9 (240)	111.9 (22)	119.3 (2)

Scenario	Rev. 2 Data Base: Max Tecw °F	Rev. 2 Data Base: Max Tccw (°F) Unit 1	Rev. 2 Data Base: Max Tccw (°F) Unit 2
SSD (2)/SSD (2) Time of LOOP 2103	105.2 (590)	112.6 (15)	112.6 (15)
SSD (2)/LOCA (2) Time of LOOP 2102	104.6 (591)	113.7 (16)	117.0 (2)
SSD (2)/LOCA (2)	104.6 (193)	112.8 (22)	120.5 (2)

a. Numbers in parentheses give the time in hours after the LOOP-concurrent event.

b. The time of event initiation is given as the day and hour; that is, 2103 designates the 21st day at 0300 hours in the design basis meteorological record.

c. This Table is based on Spent Fuel Pool heat loads that have since been revised. All of the Max T_{ccw} temperature values presented here for each scenario will increase slightly (on the order of 1°F to 2°F) to a value that is bounded by 122.9°F. See Section 9.2.5.3.

TABLE 9.2.7-1
REACTOR MAKEUP WATER SYSTEM COMPONENT DESIGN PARAMETERS

Reactor Makeup Water Storage Tank

Type	Vertical, diaphragm
Quantity	1
Volume (Nominal) (Useable)	160,000 gal 153,050 gal
Design pressure	Atmospheric
Design temperature	200°F
Material of construction	Stainless steel

Reactor Makeup Water Pumps

Type	Horizontal centrifugal, mechanical seal
Quantity	2
Design flow	300 gal/min
Design head	280 ft
Design pressure	150 psig
Design temperature	200°F
Material of construction	Stainless steel

RMWS Piping and Valves

Design pressure, temperature, and material of construction are identical to that of the reactor makeup water pumps.

TABLE 9.2.7-2

REACTOR MAKEUP WATER SYSTEM
FAILURE MODES AND EFFECTS ANALYSIS

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Safety Function Capability	General Remarks
RMWST Fill Control Valve LV-7651 (normally closed)	No safety function. Valve controls filling of RMWST from the MUD	1-6	Valve fails to open or is stuck closed	RMWST Level indication, valve position indication lights	None - Isolation valves FV-7659 and 7663 close on tank low level (non-1E). Sufficient inventory is available for safety function	Makeup is also from the BRS
			Once open, valve fails to close	RMWST Level indication, valve position indication lights	None - The RMWS Tank has a high-high level alarm to indicate that the valve failed to close. If the valve alarms, manual operation of the demineralized water pumps and the valve can be initiated. The operator has sufficient time (at least 30 minutes) to terminate the pump or manually close the valve	
RMWS Pumps (normally not operating)	Provides assured source of emergency makeup to safety systems	1-6	One pump fails to operate when called for	Discharge pressure and local flow instrumentation (both non-1E)	None - Redundant pump available	
Isolation Valves FV-7659, 7663 (normally open)	Close	1-6	One valve fails closed	Pump status light Position indication in control room	None- Redundant valve available	
RMWS Pump 1A Discharge	Open	1-6	Fails to open	Discharge pressure and local flow instrumentation (both non-1E)	None - Redundant pump available	

* Plant Modes

1. Power Operation
2. Startup
3. Hot Standby
4. Hot Shutdown
5. Cold Shutdown
6. Refueling

TABLE 9.2.7-2 (Continued)

REACTOR MAKEUP WATER SYSTEM
FAILURE MODES AND EFFECTS ANALYSIS

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Safety Function Capability	General Remarks
Check Valve RM-0003 (normally closed)						
RMWS Pumps 1B Discharge Check Valve RM-0010 (normally closed)	Open	1-6	Fails to open	Discharge pressure and local flow instrumentation (both non-1E)	None - Redundant pump available	
Class 1E AC Power Train B (Train C analogous)	Provide power to Train A AC components	1-6	Loss of power on bus	Bus undervoltage alarms ESF status monitoring for ESF diesel generator system and components ESF monitoring for system and AC components	None- Train C still available to provide system safety capability	

* Plant Modes

1. Power Operation
2. Startup
3. Hot Standby
4. Hot Shutdown
5. Cold Shutdown
6. Refueling

TABLE 9.2.7-2 (Continued)

REACTOR MAKEUP WATER SYSTEM
FAILURE MODES AND EFFECTS ANALYSIS

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Safety Function Capability	General Remarks
Instrument Air (non-safety)	None	1-6	Instrument air lost	Header pressure indication and alarms	None - Loss of instrument air causes air-operated components to go to their safety position	
ESF Actuation System Train B (analogous for Train C)	Provide activation signals as required to safety-related components	1-6	Fails to generate and send actuation signals	Loss of power or actuation train in test is alarmed by ESF monitoring. Individual bistables used to generate actuation signals are individually provided with lights, and combined with other similar inputs (for same signal), are alarmed on annunciator, all on Main Control Board	None - System safety function is assured by actuation of other train	Manual actuation of the non-operating train is available if automatic actuation does not occur

* Plant Modes

1. Power Operation
2. Startup
3. Hot Standby
4. Hot Shutdown
5. Cold Shutdown
6. Refueling

TABLE 9.2.7-2 (Continued)

REACTOR MAKEUP WATER SYSTEM
FAILURE MODES AND EFFECTS ANALYSIS

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Safety Function Capability	General Remarks
Channel III DC Power (Train B)	Provide DC power to Channel III components	1-6	Loss of DC power	ESF monitoring on UPS failure, DC trouble alarm, ESF monitoring for pump (not running, no control power)	None - Redundant train provides system capability	Pump status lights off
Channel IV DC Power (Train C)	Provide DC power to Channel IV components	1-6	Loss of DC power	ESF monitoring on UPS failure, DC trouble alarm, ESF monitoring for pump (not running, no control power)	None - Redundant train provides system safety capability	Pump status lights off

* Plant Modes

1. Power Operation
2. Startup
3. Hot Standby
4. Hot Shutdown
5. Cold Shutdown
6. Refueling

9.3 PROCESS AUXILIARIES

9.3.1 Compressed Air System

9.3.1.1 Design Bases. The Compressed Air System is comprised of both the instrument air system and the service air system. Neither of the above systems are needed to perform a safety function and are therefore non-nuclear safety (NNS). The Compressed Air Systems have design bases to:

1. Supply a sufficient quantity of instrument air to provide for all pneumatic controls, valves, and damper operators expected to operate simultaneously.

2. Supply instrument air meeting the requirements of ANSI/ISA S7.0.01-1996.

3. Regulate instrument and service air header pressure between nominal 90 psig and 140 psig max.

4. Supply a sufficient quantity of clean, oil-free service air for the operation of maintenance tools and other service air requirements, as well as a unique backup to the instrument air system in the event of failure of instrument air compressors.

5. Provide Compressed Air Systems which are in accordance with Federal requirements in the Occupational Safety and Health Act (OSHA), Sections 1910.95 and 11910.169, as well as state and local laws.

6. Provide non-Class 1E power to an instrument air compressor and dryer in the event of a loss of offsite power (LOOP).

7. The instrument air shall be free of all corrosion contaminates and hazardous gases, flammable or toxic, which may be drawn into the airstream.

9.3.1.2 System Description.

9.3.1.2.1 General: The Service and Instrument Air Systems are shown on Figures 9.3.1-1 through 9.3.1-8. Separate Compressed Air systems are provided for each unit, each having its own receivers. Facilities which are shared between units are served by compressed air header (yard loops) common to both units that can be pressurized selectively from either unit.

The Instrument Air System provides four 100-percent-capacity air compressors, four moisture separators, and two air receivers. In addition, the Instrument Air System is provided with one wet tank, two oil mist eliminators, and three dryers. The Service Air System is slaved off the instrument air system. The Closed-Loop Auxiliary Cooling Water System (CLACWS) is used to supply cooling water to three compressors while the fourth compressor is air-cooled.

9.3.1.2.2 Instrument Air System: For each unit, four instrument air compressors are provided, with one normally operating and the others on automatic standby. A decrease in instrument air header pressure to a preset low point will initiate start of a standby unit instrument air compressor.

If header pressure continues to drop, the third and fourth compressors will start at a preset pressure point. This situation will occur in the event of a mechanical failure of the normally operating air compressor, in the event of instrument air piping leaks, or in the event of an increased demand of the Instrument Air System.

The air outlet of each instrument air compressor is piped to a moisture separator, then to a wet tank. From the wet tank piping connects to two oil mist eliminators in parallel, and then to three 200% dryers that are in parallel. From the dryers piping connects to the main instrument air header. Three 200-percent-capacity prefilters, dryers and afterfilters in parallel are provided with provisions for automatic/manual switching from one to the other to assure a continued supply of clean dry instrument air in the event of a malfunction or maintenance on a filter or dryer. Dual-tower, heated regenerative dryers are provided for the Instrument Air System so that one desiccant chamber is regenerated while the other is in service. The two-dryer desiccant chamber of the operating dryer unit interchanges automatically on a time or dewpoint basis. An automatic bypass of the filters and dryers is provided in the unlikely event of all three dryers being out of service. This bypass valve opens on low instrument air header pressure and an alarm is activated when the bypass valve opens. The instrument air to the yard branch is provided with an isolation valve that automatically isolates the yard branch from the common header when the instrument air header pressure drops below the low setpoint. This arrangement is provided to direct all instrument air to the required users of the system. A secondary air source connection is supplied downstream of each instrument air compressor. This connection may be used as a secondary air source supply to another compressor, or, as an inlet connection for secondary air from another permanent plant or temporary air compressor. The maximum normal operating pressure of the Instrument Air System is a nominal 127 psig with a maximum normal operating temperature of the cooler effluent of 120°F or less

9.3.1.2.3 Service Air System: The Service Air System is slaved off the instrument air header. The outlet header from the receivers supplies the Service Air Distribution System. The Service Air is piped to headers in various buildings which serve those stations for operation of air power tools, and other services as required.

The Service Air System is isolated from the instrument air by an isolation valve. When the instrument air header pressure is reduced to a preset setpoint, then the service air is isolated by the closing of the service air isolation valve. When this valve closes an alarm is indicated in the control room.

The normal operating pressure and temperature of the Service Air System is based on the parameters of the instrument air system.

9.3.1.2.4 Interconnections Between Instrument and Service Air Systems: In each unit, the service air header is slaved off the instrument air header. A normally open control valve in this line closes automatically on low instrument air pressure at the instrument air header.

Common and shared facilities between the two units, such as the makeup demineralizer and Auxiliary Steam System, are supplied with service air from a header common to both units which makes a loop around the yard. Similarly, instrument air is piped to a common header for these facilities via a parallel yard loop. Valves are provided in the instrument air yard loop to isolate a line rupture with the capability of supplying instrument air to the shared facilities from Unit 1 or Unit 2. Check valves are provided in the instrument air yard loop to prevent high air usage on one unit from pulling down the other unit's air system.

9.3.1.3 Safety Evaluation.

9.3.1.3.1 General: Operation of the Instrument Air System is not required to perform any safety function.

The Compressed Air Systems are NNS. However, the Containment penetrations, including isolation valves, are designed to safety class (SC) 2, seismic Category I requirements. The piping is in accordance with American National Standards Institute (ANSI) B31.1, except for Containment penetrations and associated isolation valves, which are in accordance with the American Society for Mechanical Engineers (ASME) Boiler and Pressure Vessel (B&PV) Code, Section III, Class 2.

There are no safety-related, air-operated valves with SC, seismic Category I reservoirs, since upon loss of instrument air, all air-operated valves are designed to fail safe to assure against the loss of the safety function of any Engineered Safety Features (ESF) of the plant. The failure mode and effect analysis (FMEA) for loss of instrument air is addressed in the FMEA of each system (Table 9.3-2).

Each safety-related, air operated valve is provided with a filter in the air line upstream of the solenoid valve to ensure that no particulates block the solenoid ports.

The instrument air receiver vessel, service air receiver vessel, instrument air dryer vessels, and the service air dryer vessels are located in the Turbine Generator Building (TGB) on the north end and on the ground floor, as shown on the general arrangement drawing listed as Figure 1.2-5 in Table 1.2-1. As this drawing and the other associated TGB general arrangement drawings indicate, there is no safety-related equipment located in the vicinity of these vessels.

The layout and routing of the compressed air piping are based on the optimum combination of the following considerations:

1. Minimize pipe routing and connections in safety-related areas

2. Route compressed air piping in non-SC pipe chases or racks where possible

3. Provide direct and efficient distribution to the required plant areas

4. Minimize interference with plant maintenance

9.3.1.3.2 Electrical Power Failure: The motor drivers for the two instrument air compressors in each unit are connected to two separate electrical busses. A power failure of either bus will not preclude availability of a minimum of 100-percent-capacity.

Following a LOOP, the air compressors stop operating. Air-operated valves throughout the plant are arranged to fail in the safe position in the absence of air.

Should LOOP occur, instrument air may be maintained by a nonsafety-related power source. One air-cooled instrument air compressor and one dryer are connected to the nonsafety-related diesel generator bus. The instrument air emergency cooling water pump is furnished as part of the CLACWS. Refer to Section 9.2.1.1 for further details.

9.3.1.3.3 Compressor Failures: Four 100-percent-capacity redundant instrument air compressors are provided for the case of a mechanical failure of the lead compressor and to allow servicing of one compressor while the others remain operational.

9.3.1.3.4 Filter Clogging or Dryer Failure (Instrument Air): Normally, before clogging can occur, plant operators switch filters upon indication of high differential pressure across each filter and clean or replace filter elements on a periodic maintenance basis.

The three 200-plus-percent-capacity duplex dryer units positioned in parallel are provided to assure a clean dry source of instrument air. In the case of an operating dryer malfunction or dryer maintenance during plant operation, a minimum of one dryer will still be available.

In the case of a dryer automatic switching failure, filter clogging, or multiple dryer malfunctions the automatic bypass around the filters and dryers opens and maintains instrument air pressure until the filters and dryers are placed back in service. Upon opening of the bypass valve, an alarm is actuated.

9.3.1.3.5 Air Line or Receiver Rupture: As with power failure, as discussed in Section 9.3.1.3.2, should a rupture of the instrument air header or receiver occur, the plant can be safely shut down. Air headers are routed to avoid affecting safety-related equipment in the event of a rupture in either compressed air system.

An instrument air line rupture inside the Reactor Containment Building (RCB) allows air to enter the building until the Containment air-operated isolation valve can be closed. A check valve inside the Containment isolates the instrument air header inside the Containment from the instrument air header outside the building in the event of an air header or receiver rupture outside the Containment. The Service Air System Containment isolation requirements are met by a check valve inside and a manually operated valve outside the Containment. The outside valve is normally locked closed under administrative control.

9.3.1.3.6 Capability to Isolate: In addition to that already discussed, the following isolation capabilities are supplied. The Instrument Air System is equipped with isolation valves at the building takeoffs from the header so that the supply line to each building can be isolated from the main supply system. The yard loop is also provided with an isolation valve, allowing it to be isolated from the main header of each unit. In addition, at each building takeoff, the yard loop is supplied with three isolation valves, allowing isolation of the takeoff to each building (or structure) and isolation of any segment of the yard loop.

The Service Air System is equipped with isolation valves at the building takeoffs from the header so that the supply line to each building can be isolated from the main supply system. The yard loop is also provided with an isolation valve, allowing it to be isolated from the main header of each unit. In addition, at each building takeoff from the yard loop, a single isolation valve is supplied, allowing for isolation of each takeoff from the yard loop.

9.3.1.3.7 Environmental Considerations: The Compressed Air System equipment is designed to comply with federal OSHA requirements, as well as applicable state and local laws or regulations.

9.3.1.4 (Not Used)

9.3.1.5 Instrumentation Application. The instrument air compressors are provided with controls to load and unload all compressors and to automatically start and stop the backup compressors based on instrument air header pressure. Each instrument air dryer is supplied with controls to automatically initiate the regeneration of each chamber on a cyclic basis. The controls shall, at the same time, place the reactivated chamber in service. Low pressure in the instrument air header automatically opens the dryer bypass valve. Low pressure at the instrument air header automatically closes the instrument air to the yard isolation valve. Alarms are provided for compressor failure, dryer failure, low instrument and service air header pressures, dryer bypass valve open and Service Air isolation valve closed. Indication and alarm are provided in the control room for instrument and service air header pressures. Overpressure protection is provided by safety relief valves on the instrument air receivers.

9.3.2 Process and Post-Accident Sampling Systems

9.3.2.1 Design Bases.

9.3.2.1.1 Process Sampling System: The Process Sampling System (PSS) consists of the Primary Sampling System and the Secondary Sampling System (SSS). The system provides a means of obtaining representative samples for laboratory or on-line analysis. The analytical results are used to monitor plant and equipment performance and provide information to assist in operator decision making. Included are analyses performed to monitor water quality, to determine demineralizer efficiencies, and to evaluate leakage and corrosion product and fission product radioactivity concentrations.

The PSS is designed to:

1. Supply representative samples

2. Prevent hazards to operating personnel from high pressure, temperature, or radiation levels from the process fluid during all modes of operation.

3. Incorporate the following features:

a. The shortest practicable line length and smallest practicable line diameter are used to reduce time lag and minimize settling (plating) out of samples in the lines during transfer to the sample stations.

b. Sample lines are routed to avoid traps, dead legs, and dips.

c. Sample lines provide a purge flow velocity high enough to inhibit deposition of suspended solids and to not delay the sample unduly. Sample flow rates satisfy the requirements of analytical instruments on sample panels at sampling stations and for samples taken for laboratory analysis.

d. For non-continuous samples, sufficient sample volume is available to permit tests.

e. Continuous SSS samples are maintained at a constant reference temperature of 77°F ± 1° to minimize temperature compensation errors. Heat exchangers (shell and tube) are used for gross temperature control while constant temperature baths are used for final temperature control.

f. Sample pressure is held constant at or below the pressure requirements of the analyzer. Pressure control is between primary and secondary coolers.

g. Sample lines which continuously draw samples of 150°F and above are insulated, where required for personnel protection.

h. Care in taken to avoid leakage, as well as absorptive losses, especially in radioactive gas sampling.

i. Some samples carry radioactivity that requires shielding, radiation monitors in the sampling area, or long sample holdup times. In all cases, the routing of sample lines limits hazards to operating personnel.

j. Representative samples are ensured by proper arrangement of sample lines and connections, adequate purging prior to obtaining a sample, and proper handling of samples prior to the analysis.

The Process Sampling System is designed, fabricated, and tested in accordance with the applicable codes and standards shown in Table 9.3-5.

9.3.2.1.2 Post-Accident Sampling System: The Post Accident Sampling System (PASS) provides a means for obtaining representative reactor coolant fluid and Containment atmosphere samples and then analyzing the samples on-line or by use of grab samples. The analysis provides information to aid in the following: analyzing radionuclides in order to address public concerns and plan for long term recovery operations; deriving information on hydrogen concentration in containment for complementing information from the safety-grade hydrogen monitors; and analyzing highly radioactive samples from the Reactor Coolant System and Containment Sump to derive information on parameters such as boron concentration and pH of the water in the Containment Sump for confirming calculations of pH and boron concentration and confirming that potentially unaccounted for acid sources have been sufficiently neutralized. Samples and analysis can be obtained post-accident without requiring access to the Containment. The Hydrogen Monitoring System, as described in Section 7.6.5, provides hydrogen sampling capability of the Containment atmosphere.

The PASS is designed to:

1. Have the capability to obtain reactor coolant and Containment atmosphere sample.

2. Deleted

3. Obtain a sample without radiation exposure to any individual exceeding the limits of General Design Criterion (GDC) 19 assuming Regulatory Guide (RG) 1.4 source terms. An evaluation was performed to show that the dose limits are also met using the LOCA Alternative Source Terms (AST) from RG 1.183.

4. Not require an isolated auxiliary system to be placed in operation in order to sample the reactor coolant and Containment atmosphere.

5. Deleted

6. Consider the following:

    a. Sampling line purging

    b. Reducing plateout in sample lines

    c. Minimizing sample loss or distortion

    d. Appropriate disposal of sample

    e. Flow restrictions to limit reactor coolant loss from rupture of a sample line

    f. Obtaining samples representative of the reactor coolant in the core area and the Containment atmosphere following a transient or accident.

    g. Minimizing the volume of fluid to be taken from the Containment by keeping sample lines as short as possible

    h. Filtering (post-accident) the sample station ventilation exhaust with charcoal absorbers and high-efficiency particulate air (HEPA) filters.

7. Deleted

The PASS is designed, fabricated, and tested in accordance with the applicable codes and standards shown in Table 9.3-5.

9.3.2.2 <u>System Description</u>.

9.3.2.2.1 <u>Sampling Sources</u>:

9.3.2.2.1.1 <u>Process Sampling System</u> - As shown in Table 9.3-3, the PSS is used to obtain process samples from the following fluid systems.

1. Primary Sampling System:

    a. Reactor Coolant System (RCS)

  b. Residual Heat Removal System (RHRS)

  c. Safety Injection (SI) System

  d. Chemical and Volume Control System (CVCS)

  e. Reactor Makeup Water System (RMWS)

  f. Liquid Waste Processing System (LWPS)

  g. Spent Fuel Pool Cooling and Cleanup System (SFPCCS)

  h. Boron Recycle System (BRS)

  i. Deleted

  j. Steam Generator Blowdown System (SGBS)

2. Secondary Sampling System:

  a. SGBS

  b. Main Steam System

  c. Condensate System

  d. Feedwater System

  e. Auxiliary Cooling Water System (ACWS)

  f. Heater Drips and Drains System

  g. Circulating Water System (CWS)

  h. Condensate Storage System

  i. Condensate Polisher System

The process sample lines are routed to sampling stations, where provisions are included for one or more sampling methods (e.g., grab samples and continuous on-line monitoring).

Local sampling connections are provided for other fluid systems located outside of Containment. These local samples are listed in Table 9.3-4 with radiological and chemistry monitoring requirements and references to the applicable Updated Final Safety Analysis Report (UFSAR) figures. Radiological and chemical process limits are discussed in the Technical Specifications and chemistry specifications.

9.3.2.2.1.2 Post-Accident Sampling System - As shown in Table 9.3-3A, the PASS is used to obtain samples from the following sources:

1. Liquid Samples:

    a. RCS

    b. RHRS (sample point is also used to obtain SI System and Containment emergency sump samples)

    c. Containment normal sump

2. Gaseous Samples:

Containment atmosphere

9.3.2.2.2 Diagram Descriptions:

9.3.2.2.2.1 Process Sampling System -

Primary Sampling System

The primary sampling diagrams are shown on Figures 9.3.2-11 through 9.3.2-14. Each primary sample line originating within the Containment has isolation valves located inside and outside the Containment. The valves (normally closed) are operated remotely by switches in the main control room in order to select the desired sampling point. Switches are also provided in the primary sampling room to select the desired SI accumulator samples. Similar types of samples are joined into their respective common headers prior to penetrating the Containment (for example, hot let reactor coolant samples). The reactor coolant sample flow is also directed through a delay coil prior to penetrating the Containment. The delay coil is sized to provide for sufficient decay of Nitrogen-16 to permit handling of the samples in the primary sampling room.

Isolation of sample lines originating outside the Containment is normally accomplished with two manually operated valves. One valve is located near the connection to the system being sampled. The second valve is located in the primary sampling room. The sample lines are routed to the sample sink where grab samples are taken.

Samples with pressures and temperatures above safe handling values are routed through sample coolers, pressure-reducing valves, and flow control valves. The temperature and pressure reduction permits safe handling of the samples. The conditioned fluid can be routed to a purge line, to a sample vessel, or to the sample sink where grab samples are obtained. System components are located within the primary sampling room in the Mechanical-Electrical Auxiliaries Building (MEAB), with the exception of two sample sinks which are located outside the sampling room. Each is equipped with a ventilating hood and demineralized water supply.

Certain samples are local grab samples and are not routed to central sampling locations. Only those samples shown on the Primary Sampling System diagrams Figures 9.3.2-11 through 9.3.2-14, are routed to central sampling locations.

Purge lines are provided for flushing the sample lines to ensure that representative samples are obtained. Primary Sampling System purge flow is returned to the CVCS or discharged to the radioactive vent and drain system. The purge volume for each sample line is minimized by the use of sample lines having a small internal diameter and by providing short piping runs wherever possible.

Secondary Sampling System

The SSS diagrams are shown on Figures 9.3.2-1 through 9.3.2-10. The steam generator (SG) blowdown sample lines originate outside the Containment. The sample lines are isolated from the Containment by the SG blowdown Containment isolation valves. The SG blowdown isolation valves automatically close on an SI signal or an auxiliary feedwater (AFW) initiation signal which isolates the blowdown sample line.

Each blowdown sample is passed through a sample cooler and is routed to the secondary sampling room in the TGB. The cooled fluid flows through a pressure reduction valve and a flow control valve. The sample fluids are further conditioned in a common constant temperature bath so the outlet temperature is 77°F $\pm$ 1°F. The sample is then routed through in-line instrumentation for chemical monitoring. The sample is discharged to the seal leakoff tank. Grab samples of blowdown fluid are taken in the SG sample sink located in the secondary sampling room in the TGB. These samples are taken upstream of the in-line analyzers. Each SG has its own sample line, components, and instrumentation to facilitate SG chemistry monitoring.

The remaining sample points (Table 9.3-3) in the system originate outside the Containment. These sample lines have manually operated isolation valves located in the secondary sampling room in the TGB. These sample lines are equipped with sample coolers, constant temperature bath, pressure control valves, and instrumentation as required for each particular sample. Grab samples can be taken at the secondary sample sinks. Purge paths are provided for all sample paths to ensure that representative samples are obtained. These samples are also discharged to the seal leakoff tank.

The arrangement of sample lines and connections precludes traps and dead legs. Certain samples are local grab samples and are not routed to the secondary sampling room. Only those samples shown on the SSS diagrams, Figures 9.3.2-1 through 9.3.2-10, are routed to the secondary sampling room.

9.3.2.2.2.2 Post-Accident Sampling System - The PASS diagram is shown in Figure 9.3.2-15. The PASS sample lines originate outside the Containment and have isolation valves outside the Containment for isolation capability. The isolation valves (normally close) are operated remotely by individual switches located in the main control room in order to select the desired sample point. Portions of the sample lines for the PASS are common to the sample lines for the Primary Sampling System. Portions of the Containment atmosphere sample lines are common to the Hydrogen Monitoring System sample lines.

Liquid sample return lines are provided to the volume control tank (VCT) and condensate polishing regeneration waste collection tank (CPRWCT) for normal operation and to the pressurizer relief tank (PRT) inside Containment for post-accident conditions. Automatic interlocks are provided to ensure that flow is directed to the PRT instead of the VCT or CPRWCT on high radiation. The Containment atmosphere samples and evolved gases from liquid samples are routed to the Containment.

Provisions are available at the sample panel and conditioning rack to condition samples. Component cooling water (CCW) provides a source of cooling water during normal and post-accident conditions. Nitrogen is supplied from the low pressure nitrogen gas supply system and from nitrogen bottles as backup. The nitrogen is used for flushing gaseous sample lines and as a backup for compressed air for operating panel-mounted control valves. Demineralized water is provided for liquid sample line flushing and dilution of liquid grab samples.

9.3.2.2.3 Component Description:

9.3.2.2.3.1 Process Sampling Component Description - The PSS components are constructed from stainless steel and are compatible with the operating temperatures, pressures, and chemical composition or the various plant fluid systems being sampled. The design and expected operating conditions of the fluids being sampled are given in Table 9.3-3. Applicable design codes are summarized in Table 9.3-5.

Sample Coolers

The sample coolers are of shell and tube design. Sample fluid flows through the tube side (stainless steel) and cooling water flows through the shell side (carbon steel). Safety relief valves with properly routed discharges are provided to prevent over-pressurization of both the shell and tube sides of the coolers.

Pressure-Reducing and Flow Regulating Equipment

The pressure-reducing and flow-regulating equipment consists of a variable orifice valve in series with a pressure-regulating valve, and is provided for specific sample lines. Adjustments are made such that the purge flow rate is equivalent to the sample flow rate. In addition, where applicable, the pressure and flow in the sample lines are regulated to be compatible with the in-line monitoring instrumentation. The pressure-reducing and flow-regulating equipment is constructed from stainless steel.

Sample Vessels

Sample vessels are used for all gas sampling and for liquid samples of the systems which normally contain radioactive gases. Use of the sample vessels prevents the release of gas during the collection period. The vessels are designed according to the codes and standards of Table 9.3-5. Sample vessels are located in enclosed hoods above a sample sink to prevent the release of radioactivity during sampling and handling operations. The sample vessels are constructed of stainless steel.

Sample Sinks

Separate sample sinks are provided for Primary Sampling System samples, for SG blowdown samples, and for additional turbine plant samples. In this manner, samples are segregated to permit proper disposal. Each primary sink located in the MEAB is equipped with a ventilated enclosure (hood). Ventilation is provided for the sample hood with a nearly constant flow velocity of 150 ft/min through the working face of the hood. The ventilation prevents release of airborne radioactivity to the sampling room. The sinks are of stainless steel construction and have raised edges to reduce liquid spillage and contamination of sampling room surfaces. The sinks are supplied with demineralized water.

9.3.2.2.3.2 Post-Accident Sampling System Component Description - The PASS components are constructed from stainless steel and are compatible with the operating temperatures, pressures, and chemical composition of various plant fluid systems being sampled. The design and operating conditions of the fluids being sampled are given in Table 9.3-3A. The applicable design codes are summarized in Table 9.3-5.

The PASS is a remotely operated panel system consisting of the following:

1. Liquid and Gas Sample Panel (LGSP). This panel houses the in-line instrumentation, gas stripping equipment, dilution loops, and grab sample features. The LGSP provides the capability to obtain diluted and undiluted liquid and gas samples.

2. Instrument Panel (IP). This panel provides remote indication of analytical parameters associated with the operation of the LGSP. Since no sample fluids enter this panel, shielding is not provided.

3. Electrical Control Panel. This panel houses the electrical support equipment necessary for the operation of the LGSP, IP, and Sample Selection/Conditioning Rack. A lighted semi-graphic display shows the status of the valves and equipment in the LGSP.

4. Sample Selection/Conditioning Rack. This rack allows remote selection of the sample sources. The sample coolers are provided in this rack for reducing the liquid sample temperatures.

5. Fume Hood. A fume hood is also provided for local wet chemistry operations.

6. Waste Collection Unit (WCU). The WCU consists of a 20-gallon tank with a liquid waste pump and a gas compressor. The WCU collects the discharge of the analyzers.

Sample Coolers

The sample coolers are of shell and tube design. Sample fluid flows through the tube side (stainless steel) and cooling water flows through the shell side (carbon steel). Over-pressure protection is provided as required.

Sample Vessels

Sample vessels may be used to obtain grab samples during normal operations. Post-accident grab sampling is accomplished by means of a syringe and shielded sample cask with isolation valves and quick disconnects.

9.3.2.2.4 System Operation:

9.3.2.2.4.1 Process Sampling System - Process liquid sampling is accomplished after sufficient purging of the line is performed to ensure that a representative sample is obtained. The purging is performed with a cooled and regulated flow. The purge volume from the Primary Sampling System process samples is recirculated to the CVCS or discharged to the radioactive vent and drain system. After purging, liquid samples are collected either in an installed sample vessel or in sample containers at the sample sink. When using a sample vessel, inlet and outlet valves on the sample vessel are closed to obtain the sample. Sample flow in the line is stopped, and the sample vessel is removed from the system. Collected samples are analyzed for chemical purity and radioactivity concentration. The results are used to monitor system and equipment performance. The operations performed to obtain liquid samples are similar for both the Primary Sampling and the SSS samples. Special precautions are taken to prevent the spread of contaminants during sampling of systems containing radioactivity.

Continuous samples are taken from SSS sources. The sample flow is conditioned by the sample coolers, pressure reduction equipment, and the constant temperature bath. The sample flow passes through in-line monitors which are equipped with indicators and alarms to provide continuous surveillance of selected process streams without additional operator action.

Local gaseous samples are collected in stainless steel sample vessels equipped with valves on each end. The sample lines are purged with the sample fluid or nitrogen. The purge volume is returned to the system being sampled. After purging, the sample vessel valves are closed, the sample flow stopped, and the vessel removed from the system for analysis of the contents. Sources from which local gaseous samples are periodically taken are shown in Table 9.3-4.

Local liquid samples are taken either in installed sample vessels or as grab samples in a sample container. The local samples are taken at a local sampling station furnished for the insertion of the sample container or vessels. Local sampling stations for normally radioactive samples are outside a shield wall. Purging the short lines is performed as described above. The stations include drains which are piped to appropriate sumps. Local samples are taken in a manner identical to those described above for similar types of process samples. Samples from tanks are collected after the tank contents are thoroughly mixed, either by a mixer or by recirculation of the tank contents. Sources from which local liquid samples are periodically taken are shown in Table 9.3-4.

The Primary Sampling System is designed for intermittent operation. Samples are obtained under conditions ranging from full-power reactor operation to cold shutdown. Sample lines penetrating the Containment automatically close on a Containment isolation signal. The sample flow rates and pressures are manually controlled at the sampling station.

9.3.2.2.4.2 Post-Accident Sampling System - The PASS is designed to operate under both normal and post-accident conditions. Samples arrive at the PASS using either the system pressure as the motive force or pumps provided as part of the PASS. Pumps are designed with the necessary net positive suction head (NPSH) for obtaining samples. Samples are obtained at the sample panel using controls provided at the remotely located control panel.

Analysis of liquid and gaseous samples is accomplished after purging has been performed to ensure a representative sample is obtained. Liquid sample lines are purged to the VCT or the CPRWCT or the PRT. The Containment atmosphere line is purged back to the Containment.

Sampling and analysis are performed on a continuous or selective basis during post-accident conditions. An in-line gross gamma activity detector for both liquid and gaseous samples is also provided in the sample panel.

Grab sampling capability is provided for obtaining samples for analysis in the laboratory. Post-accident grab sampling is accomplished by a syringe or shielded sample casks with isolation valves and quick release disconnects. Grab sampling can be achieved by operator action at a remote control panel in order to reduce operator exposure to radiation. An integral spray system is provided in the LGSP for washdown and decontamination prior to maintenance.

The PASS panels are powered from a reliable power supply to ensure system operation in case of LOOP.

Valves outside the PASS panels which are used to select the desired sample are also Containment isolation valves. These valves are powered form the ESF electrical busses, which are backed up by the ESF standby diesel generators (SBDGs). The valves are Class 1E equipment and are qualified for the conditions in which they must operate.

Cooling water to the PASS is supplied by the CCWS. Operator action is required to open valves connecting the PASS to the CCWS following an accident. These valves are operated from switches in the main control room. These valves are Class 1E and are qualified for the conditions in which they must operate.

9.3.2.3 Safety Evaluation. Separate process and post-accident sampling systems are furnished for each unit, including provisions for sampling rooms and a chemical laboratory, with the exception of an ion chromatograph which is mounted on a portable cart and is common to both units.

The operation of the systems is not essential for plant safety. Therefore, in the unlikely event of an accident, all sample lines which pass through the Containment are automatically isolated by fail-closed valves outside and inside the Containment. These valves and piping associated with the Containment are SC 2 and are seismic Category I design. Portions of sample lines beyond the outside Containment isolation valve are not part of the RCPB and are not designed to seismic Category I requirements. Failure of sample lines outside the Containment does not affect the RCPB or the capability to shut down the reactor. Failure of the components would not result in offsite exposure in excess of the guidelines of 10CFR100. Potential loss of coolant from rupture inside the Containment of sample lines connected to the RCPB is limited by passive flow restrictors at the sample connection to the primary loop. Interfaces with SC 1, 2, or 3 fluid systems are made at appropriate isolation valves in accordance with ANSI N18.2, 1973.

The arrangement of the sample lines is such that the high-pressure and high-temperature portions of the lines are located in areas not normally subject to personnel entry. In addition, high-temperature lines above 150°F are insulated as required for personnel protection. The lines are routed to minimize the amount of exposed piping in the sampling rooms. Sampling operations for the PASS can be controlled from a control panel located remotely from the sample panel; this minimizes radiation exposure of personnel. Also, post-accident sample purges are returned to Containment. Sample lines are routed through areas provided with drains or sumps. Sample line fluid is collected in the drains or sumps should a sample line rupture occur. In addition, because of the small sample line size and routing, the resulting flow rate will be small and would not impose a serious hazard from pressure and temperature to operating personnel. Operator action to isolate the sample line is performed by shutting the valve at the sample line connection.

High-temperature lines are provided with sample coolers to reduce the fluid temperature to an acceptable level safe for handling. Instrumentation is provided so that the operator can note the temperature and pressure prior to withdrawing a sample.

The reactor coolant loop samples are directed through a delay coil located inside the Containment. The delay coil provides for the delay of short-lived isotopes, especially Nitrogen-16. Where required, sample lines are shielded to minimize the radiation exposure of personnel. Shielding requirements are discussed in Section 12.1.

The primary and SG blowdown sample sinks are fitted with enclosed ventilated hoods. The building exhaust system sweeps the air from the sampling area, exhausting it through the system. Any radioactive gases released during sampling are therefore exhausted through the hood away from the operators. Area ventilation is provided for the PASS station and for the Radio Chem Lab and Sample Panel rooms. The exhaust air for the PASS station discharges into the Fuel Handling Building (FHB) heating, ventilating, and air-conditioning (HVAC) system for charcoal and HEPA filtering post-accident. The Radio Chem Lab and Sample rooms are equipped with an independent charcoal and HEPA filtering system. The FHB HVAC system is described in Section 9.4.2 and the Mechanical Auxiliary Building (MAB) system is described in Section 9.4.3.

Safety relief valves vented to drain headers are provided on the PSS sample lines to prevent over-pressurization. Pressure reduction and regulation valves are also provided so that operators are exposed to samples only at controlled pressures.

Measures taken to ensure that operator exposures are as low as is reasonably achievable (ALARA) are discussed in Chapter 12.

9.3.2.4 Test and Inspections. Each component is inspected and cleaned prior to installation. Instruments and analyzers are calibrated. The system is operated and tested initially with regard to flow paths, flow capacity, and mechanical operability. The continuous monitors are periodically tested, calibrated, and checked against grab sample results to ensure proper instrument response and alarm functions. Since most components are used regularly during power operation, as well as shutdown and cooldown periods, the availability and performance of the sampling systems can be evaluated regularly.

9.3.2.5 Instrumentation Application. Local temperature indicators are provided on the sample lines downstream of sample coolers. These instruments are used to determine the sample temperature before a sample is drawn. Temperature indicators are also used in other lines containing monitoring equipment which provides temperature-sensitive data such as pH and conductivity.

Local pressure indicators are provided downstream of the pressure-reducing valves to assist in the adjustment of pressure reduction valves provided to protect the equipment and personnel.

Flow indicators or metering valves are provided to assist the manual adjustment of sample flow rates to the analyzers, sample vessels, and sample sinks. The indicators are also used in the adjustment of the purge flow rates.

Instrumentation for the PSS is shown on Figures 9.3.2-1 through 9.3.2-14. The PASS is shown on Figure 9.3.2-15. Th instrumentation provides the functions of alarming, recording, and analyzing process variables.

Alarms and indicators are displayed on local panels in the sampling rooms.

Radiation monitoring instrumentation for the sample rooms is discussed in Section 11.5.

9.3.3 Equipment and Floor Drain System

9.3.3.1 Design Bases. The Equipment and Floor Drain System (EFDS) is designed to collect and convey various operational waste liquids from their points of origin to their points of collection for processing or ultimate disposal under controlled conditions. The following design bases are used to ensure system integrity during normal plant operation and to preclude any danger to the environment or the health and safety of plant personnel and the general public:

1. Drain system which carry radioactive waste contain no piping connections that would allow inadvertent transfer of radioactive fluids into nonradioactive piping systems. Radioactive wastes are collected separately in tanks or sumps, based upon their chemical makeup, to facilitate their treatment in the LWPS.

2. ESF equipment is protected from damage due to flooding caused by reverse flows through the drainage system by either the drain system design or building design features.

3. Drains and sumps in the RCB, MAB, and FHB are considered potentially radioactive except for the secondary drains, essential cooling water drains, and storm drains. SG blowdown treatment system is located in the MAB and its drains are handled as radioactive drains. All potentially radioactive sumps in these areas are lined.

   Drains and sumps from the TGB and Isolation Valve Cubicle (ICV) are normally nonradioactive and are processed through the oily waste system through a radiation monitor. The radiation monitor isolates the TGB sump flow to the oily waste system if radiation is detected.

   Drains from the condensate polisher in the TGB are collected separately in the condensate polishing area sump. These drains are pumped to a total dissolved solids (TDS) tank where they are sampled prior to discharge to the neutralization basin (if nonradioactive) or to the LWPS (if radioactive).

4. Effluents from the floor and equipment drains in the Diesel-Generator Building (DGB), Machine shop, and Makeup Demineralizer Building, along with storm water drainage and effluents from the chemical drains in battery rooms and neutralizing tank areas, are not considered to be potentially radioactive. DGB and Machine Shop drains are processed through oil removal equipment. Effluent from the Makeup Demineralizer Building is processed through the nonradioactive Chemical Waste System.

5. Airborne radioactivity is not allowed to flow from more radioactive areas to less radioactive areas through the floor drain system in the MAB and FHB. Because the RCB is a limited and controlled access area in its entirety, with airborne radioactivity concentrations expected to be uniform throughout, airborne radioactivity is not similarly controlled in the RCB. The migration of airborne radioactivity in the MAB and FHB is in the direction of lower to higher radioactivity because of the design of the HVAC systems. See Sections 9.4.2.1 and 9.4.3.1 for further details.

6. Concrete floors are pitched to floor drains located at low points in the same area to facilitate floor drainage and prevent water accumulation.

9.3.3.2 System Description. The EFDS is segregated into radioactive and nonradioactive classes of liquid wastes and is described in the following sections. A description of processing and discharge facilities for radioactive liquid wastes is given in Section 11.2. Protection from the effects of internal flooding are discussed in Section 3.4.

Reactor coolant grade equipment drains are collected within the RCB in the Reactor Coolant Drain Tank (RCDT), which is part of the LWPS. See Section 11.2.2 for further discussion.

9.3.3.2.1 Drainage Provisions: The majority of radioactive and nonradioactive drains, except those servicing filters and demineralizers, are routed to open equipment drains or combination equipment and floor drains. As discussed in Section 3.4.1.1, drains are designed such that there will be no inadvertent introduction of external flood water through these lines into seismic Category I structures. Check valves are utilized to prevent backflow from external flooding.

A listing of the lines which have external discharge capability from seismic Category I building is provided in Table 9.3-14. A typical design of the backflow prevention features in these lines is provided in Figure 9.3.3-11.

Floor drains are placed throughout the plant to collect leakage and aid in floor cleaning. These floor drains are connected to collection sumps or tanks having pumps to convey the collected volume to the appropriate collection tanks for processing, or they are connected directly to the collection tank.

Certain gravity drain lines receive sump pump flow from the lower elevation radioactive sumps. These gravity drain lines carry the sump pump flow, along with leakage collected, directly to the LWPS collecting tanks.

The radioactive drain system gravity drain lines are designed for the largest of the following flows:

1. Equipment leakage

2. Expected sump pump discharge flows

3. Controlled drainage of vessels or equipment

4. Decontamination washdowns from simultaneous use of two 1-in. hoses at 35 gal/min flow each

Radioactive gravity drain piping is stainless steel and buttwelded to prevent crud pockets where accumulation of solids may occur. Drain lines are adequately sloped to ensure complete drainage of piping. Slotted cover plates are an integral part of all floor drains to prevent solids from entering drain piping and causing subsequent clogging.

Drains from the solid waste processing area are equipped with screens and strainers to prevent solid particles and bead resins from entering the LWPS collection tank.

Safety-related tanks are located in compartments having elevated openings. Sumps and pumps are provided in these compartments, except for the boric acid tank (BAT) compartment, to transfer the liquids to the appropriate tanks for processing. The BAT compartment is provided with a normally covered floor drain.

Nonsafety-related tanks, except the floor drain tank (FDT), are located in cubicles containing floor drains and elevated thresholds.

The FDT is located in a watertight compartment with a watertight door. This compartment contains a drain line with a locked-closed valve so that overflows and leakage may be contained within the compartment and drained at a rate that may be processed by the LWPS. The valves are accessible from outside the FDT compartment.

The drains from the Solid Waste Processing System (SWPS) compartment have screens to collect bead resin overflow from the tank.

9.3.3.2.2 Painting - The criteria for painting of equipment and areas are addressed in the general painting specification for the facility. This specification classifies the coating areas and specifies the methods to be employed in surface preparation and application of coatings. The coating schedule specifies the particular type of coating to be used on components or plant areas within each coating classification.

Coatings for areas subject to radiological contamination are selected considering radiation resistance, ease of decontamination, chemical resistance, and physical properties, i.e., wear and abrasion resistance, flammability limits, and thermal conductivity. Generally, epoxy-polyamide and modified phenolic coatings are used on equipment and areas subject to radiological contamination.

9.3.3.2.3 ESF Equipment and FHB Leak Detection and FHB Drain System: Detection of excessive leakage from the Safety Injection System (SIS) and Containment Spray System (CSS) and rooms in the FHB is provided by level instrumentation in the appropriate sump. Operation of these sumps is described in Section 9.3.3.2.4. Each train of the SIS and CSS is located in a separate room with its own sump and duplex sump pumps. The sump pumps and associated piping from the SIS and CSS equipment rooms are designated as nonseismic equipment. The leak detection level instrumentation is seismic Category I and Class 1E. Failure of the nonseismic pumps or piping would not affect the functional integrity of the equipment in the room since the equipment is located in a way that would provide sufficient time for operator action.

Leakage and flooding into SIS/CSS pump compartments are alarmed on the Qualified Display Processing System (QDPS) by switches on the level instrumentation for the collection sumps in these compartments. Two independent Class 1E high level alarms are provided. Only one alarm must remain functional to provide the minimum leak detection capability.

Equipment and area drains for the remainder of the FHB are routed to a sump tank located on the lowest elevation. The sump tank is served by duplex pumps to transfer the collected leakage to the FDT located in the MEAB.

A separate sump and pump are provided in the pump room under the cask pool to collect decontamination liquids from the cask decontamination area and any leakage from the LWPS surge tank.

The piping diagram for this portion of the system is shown on Figures 9.3.3-1 and 9.3.3-3.

9.3.3.2.4 Sump Operation

All radioactive sumps in the RCB are lined with stainless steel. All radioactive sumps in the MAB and FHB are lined with fiberglass. These liners prevent buildup of radioactive material into the concrete that forms each sump.

Sumps throughout the plant are provided will full capacity pumps. Sump and sump pump parameters are listed in Table 9.3-8.

Duplex pumps, except for the SIS/CSS sump pumps, are controlled in the following manner: A level switch-alternator system starts one of the pumps when the water reaches a high level and stops the pump when the level drops to the low-level point. When the level rises to the high-level point again, the level switch-alternator starts the other pump. Should the level continue to rise, the level switch-alternator will start the second pump.

The SIS/CSS pump compartment sumps have level alarms which are actuated in the main control room should the level rise above established setpoints. One level switch automatically activates an alarm at a preset level. The first pump is then manually started. After the water level has been lowered to a preset level by pump operation, the pump is automatically deenergized and the alarm is cleared. If the water level continues to rise with one pump operating, the second level alarm sounds and activates a high-high alarm. The second pump is then manually started.

Single pumps are manually operated unless otherwise specified. Each sump with a single pump has a single level switch which activates an alarm when the sump level reaches a preset level. Each alarm requires operator attention. The operator will start the pump and the level switch will deenergize the pump when the water has been lowered to a preset low level.

The single pumps in the MEAB HVAC area and battery room, the RCB, and the basement of the FHB are automatically controlled by a level switch in the sump. Each sump is provided with two level switches. One energizes the pump at a preset high level and deenergizes the pump at a preset low level. If the sump inleakage exceeds the pump capacity or the level switch controlling the pump malfunctions, the rising water level is detected by the second level switch, which actuates a high-high level alarm, alerting operating personnel.

Minimum water level is maintained in each sump as required by the pump design. For lines penetrating the Containment, valves on both sides of the penetration close upon a Containment isolation signal.

The sump pumps located in the SI pump and Containment spray pump cubicles are sized to accommodate a design basis leak of 50 gal/min from pump seal failures.

9.3.3.2.5 Radioactive Equipment and Floor Drain System: Equipment drains and leakage from components located in the MAB are collected by gravity drains and sumps. Floor and equipment drains at E1. 41 ft and above are drained by gravity to one of the LWPS collection tanks. Floor drains from E1. 10 ft, E1. 19 ft, and E1. 29 ft are directed to sumps at E1. 10 ft which are then pumped to the waste collection tanks.

With the exception of the FDT, tank compartments have elevated thresholds and drain to a floor sump. The FDT is located in a watertight compartment. This compartment is drained to a floor sump by a line containing a normally locked closed isolation valve accessible from outside the compartment. This allows the compartment to be drained at a rate that can be processed by the LWPS.

Five sumps are provided on the lowest elevation for collection of floor and compartment drainage. The collected drainage is then transferred to the FDT for processing. Each sump has duplex pumps with alarm provisions, as described in Section 9.3.3.2.4.

The piping diagram for the radioactive equipment drains and sumps in the MAB is shown on Figures 9.3.3-1 and 9.3.3-5 through 9.3.3-10.

Certain drains for equipment located within the RCB are collected in the containment normal sump and secondary containment normal sump. The leakage collected in the containment normal sump may be transferred to the waste holdup tank (WHT), FDT, or the laundry and hot shower tank (LHST). The flow from the containment normal sump is measured by a flow totalizer. Both the sump liquid level and the flow totalizer are part of the RCPB Leak Detection System described in Section 5.2.5. The containment secondary sump content is pumped into a gravity drain line which drains into the containment normal sump. The piping diagrams for this portion of the system are shown on Figures 9.3.3-1 and 9.3.3-2.

Chemical waste from the radiochemical laboratory drains and decontamination areas are routed to the LWPS condensate polishing regeneration waste collection tank for collection prior to processing.

Laundry and hot show drains are routed to the LWPS laundry and hot shower tank for collection and treatment by the LWPS. Drains from decontamination areas containing detergent solutions can also be routed to the LWPS laundry and hot shower tank.

9.3.3.2.6 Nonradioactive Equipment and Floor Drain System: The TGB drains are collected and conveyed to the TGB sumps, where they are pumped through oil separators to the sanitary waste plant discharge to the reservoir. Provisions for continuous radiation monitoring are incorporated to detect trace amounts of radioactivity which could be present during operation with SG tube leaks.

Leaks and drainage from the AFW pump room are collected in a sump containing duplex sump pumps and conveyed to the TGB sump.

Spills, leaks, and water resulting from the use of the emergency shower and eyewash in the battery rooms are collected in a sump on the lowest level of the Electrical Auxiliary Building (EAB).

A sump is provided on the lowest level in the EAB HVAC area to collect leakage from the HVAC equipment. This leakage is conveyed to the ECW sump.

A sump is provided on the lowest level in the FHB HVAC intake air flow path to collect condensate from the normal HVAC supply air system. This condensate is pumped from the isolated equipment sump to the Neutralization Basin.

Leakage from the diesel generator area is collected in sumps in each room containing duplex sump pumps, and is conveyed to the Oily Waste Processing System.

The Storm Water Drainage System collects rainwater from building roofs and conveys such liquids to the external Storm Water System. Design of this system ensures complete isolation from all other drainage systems within a structure. Storm water piping is not routed exposed through essential electrical areas or rooms. The system is designed to accommodate a 6-in./hr rainfall.

9.3.3.3 Safety Evaluation. The equipment and floor drain leak detection instrumentation serving the SIS/CSS pump compartments is designed to Class 1E requirements. The instrumentation indicates inleakage or flooding in these compartments so that operators can take corrective actions to mitigate the consequences of failure. Redundancy of alarm functions is provided in the sumps serving the SIS/CSS pump compartments by the use of two separate strings of level detection equipment.

The Floor Drain Piping System is arranged to prevent the backup of water into areas housing essential equipment, if such backup will endanger the equipment. A radiological evaluation of normal operation and postulated tank ruptures of the LWPS is presented in Section 11.2. Radiation protection for in-plant personnel is discussed in Sections 12.1 and 12.2.

9.3.3.4 Test and Inspections. Tests and inspections are performed to ensure that:

1. All welded joints in the radioactive EFDS are visually inspected after installation and prior to encasement, if applicable. Each completed section of the Floor Drain System is subjected to a hydrostatic pressure test of at least 10 ft of water. In some instances, the completed system is air tested at 5 psig pressure in lieu of a water test.

2. The plant EFDS is proven operable by its use during normal plant operation.

3. Preoperational tests of the systems are performed by introducing water into the sumps.

9.3.3.5 Instrumentation Application. Sufficient instrumentation is included in the system to ensure proper operation during normal operation and to alert the operators to uncontrolled leakage into the Containment, FHB, and the MAB sumps.

The instrumentation application for sump pump operation is described in Section 9.3.3.2.4. Provisions are made for local manual control of each sump pump except the containment normal sump and secondary containment normal sump pumps. Control switches with status-indicating lights are provided in the control room for the Containment normal and secondary Containment normal sump pumps and the Containment isolation valves.

Leak detection for the ESF equipment is described in Section 9.3.3.2.3. Level switches in the SIS and CSS sumps alarm in the control room on high and high-high level. The flow monitored on the Containment normal sump pump discharge is part of the RCPB Leak Detection System as is the level instrumentation for the Containment normal and secondary Containment normal sumps. Refer to Section 5.2.5 for a discussion of the instrumentation in this system.

9.3.4 Chemical and Volume Control System/Boron Recycle System

9.3.4.1 Chemical and Volume Control System. The CVCS, shown on Figures 9.3.4-1 through 9.3.4-5, is designed to provide the following services to the RCS:

1. Maintenance of programmed water level in the pressurizer; i.e., maintaining the required water inventory in the RCS

2. Maintenance of seal water injection flow to the reactor coolant pumps (RCPs)

3. Control of reactor coolant water chemistry conditions, activity level, soluble chemical neutron absorber concentration, and makeup

4. Supplying means for filling, draining, and pressure testing of the RCS

5. Provide reactor coolant purification during normal operation, refueling, and cold shutdown

6. Provide safety grade boration and makeup capabilities for cold shutdown

7. Provide a means to purify fresh or recycled 4 percent boric acid. Portions of the CVCS are used to provide safety-related boration and RCS inventory control following a Safe Shutdown Earthquake (SSE) and a LOOP (Appendix 5.4.A).

9.3.4.1.1 Design Bases: Quantitative design bases are given in Table 9.3-9, with qualitative descriptions given below.

9.3.4.1.1.1 Reactivity Control - The CVCS regulates the concentration of chemical neutron absorber (boron) in the reactor coolant to control reactivity changes resulting from the change in reactor coolant temperature between cold shutdown and hot full-power operation, burnup of fuel and burnable absorbers, buildup of fission products in the fuel, and xenon transients.

Reactor Makeup Control

1. The CVCS is capable of borating the RCS through either one of two flow paths and from either one of two boric acid sources.

2. The amount of boric acid stored in the CVCS always exceeds that amount required to borate the RCS to cold shutdown concentration, assuming that the control assembly with the highest reactivity worth is stuck in its fully withdrawn position. This amount of boric acid also exceeds the amount required to bring the reactor to hot shutdown and to compensate for subsequent xenon decay.

3. The CVCS uses the reactor makeup control process to accomplish the load follow function without the use of the boron thermal regeneration process. CN-3170

Boron Thermal Regeneration

The CVCS is designed to control the changes in reactor coolant boron concentration to compensate for the xenon transients during load follow operations, without adding makeup for either boration or dilution.

9.3.4.1.1.2 Regulation of Reactor Coolant Inventory - The CVCS maintains the coolant inventory in the RCS within the allowable pressurizer level range for all normal modes of operation, including startup from cold shutdown, full-power operation, and plant cooldown. This system also has sufficient makeup capacity to maintain the minimum required inventory in the event of minor RCS leaks (see the Technical Specifications for maximum allowable RCS leakage).

9.3.4.1.1.3 Reactor Coolant Purification - The CVCS is capable of removing fission and activation products, in ionic form or as particulates, from the reactor coolant in order to permit access to those process lines carrying reactor coolant during operation and to reduce activity releases due to leaks.

9.3.4.1.1.4 Chemical Additions for Corrosion Control - The CVCS provides a means for adding to the RCS chemicals that control the pH of the coolant during initial startup and subsequent operation, scavenge oxygen from the coolant during startup, and counteract the production of oxygen in the reactor coolant due to radiolysis of water in the core region.

The CVCS is capable of maintaining the oxygen content and pH of the reactor coolant within limits specified in Table 5.2-4.

9.3.4.1.1.5 Seal Water Injection - The CVCS is able to continuously supply filtered water to each RCP seal, as required by the RCP design.

9.3.4.1.1.6 Hydrostatic Testing of the Reactor Coolant System - The CVCS is capable of supplying water at the maximum test pressure specified to verify the integrity of the RCS. The hydrostatic test is performed prior to initial operation and is part of the periodic RCS inspection program.

9.3.4.1.2 System Description: The CVCS is shown on Figures 9.3.4-1 through 9.3.4-5, with system design parameters listed in Table 9.3-9. The codes and standards to which the individual components of the CVCS are designed are listed in Section 3.2. The CVCS consists of several subsystems: the Charging, Letdown, and Seal Water System; the Reactor Coolant Purification and Chemistry Control System; the Reactor Makeup Control System; and the Boron Thermal Regeneration System.

9.3.4.1.2.1 Charging, Letdown, and Seal Water System - The charging and letdown functions of the CVCS are employed to maintain a programmed water level in the RCS pressurizer, thus maintaining proper reactor coolant inventory during all phases of plant operation. This is achieved by means of a continuous feed and bleed process, during which the feed rate is automatically controlled based on pressurizer water level. The bleed rate can be chosen to suit various plant operational requirements by selecting the proper combination of letdown orifices in the letdown flow path.

Reactor coolant is discharged to the CVCS from a reactor coolant loop cold leg; it then flows through the shell side of the regenerative heat exchanger (HX), where its temperature is reduced by heat transfer to the charging flow passing through the tubes. The coolant then experiences a large pressure reduction as it passes through the letdown orifice(s) and flows through the tube side of the letdown HX, where its temperature is further reduced. Downstream of the letdown HX, a second pressure reduction occurs. This second pressure reduction is performed by the low-pressure letdown valve, the function of which is to maintain upstream pressure, thus preventing flashing downstream of the letdown orifices.

The coolant then flows to the letdown filters and then on to the mixed-bed demineralizers. One or both of the letdown filters may be used as needed for purification. If the filters are not needed, then the filter bypass line is used. The flow may then pass through one of the cation-bed demineralizers which are used intermittently when additional purification or lithium control of the reactor coolant is required.

From a point upstream of the Boron Thermal Regeneration System (BTRS) or from a point upstream of the reactor coolant filters, a small sample flow may be diverted from the letdown stream to the Boron Concentration Measurement System (BCMS) (Section 7.7). The readout on the boron concentration is given in the main control room.

During reactor coolant boration and dilution operations, especially during load follow, the letdown flow leaving the demineralizers may be directed to the BTRS. The coolant then flows through one of the two reactor coolant filters and into the VCT through a spray nozzle in the top of the tank. Hydrogen (from the Pressurized Gas Distribution System [PGDS]) is supplied to the VCT, where it mixes with fission gases which are stripped from the reactor coolant into the tank gas space. The contaminated hydrogen is vented to the Gaseous Waste Processing System (GWPS). The partial pressure of hydrogen in the VCT determines the concentration of hydrogen dissolved in the reactor coolant. This controls the concentration of oxygen produced by radiolysis of water in the core.

Three pumps (one positive displacement pump and two centrifugal charging pumps) are provided to take suction from the VCT and return the cooled, purified reactor coolant to the RCS. Normal charging flow is handled by one of the two centrifugal charging pumps. This charging flow splits into two paths. The bulk of the charging flow is pumped back to the RCS through the tube side of the regenerative HX. The letdown flow in the shell side of the regenerative HX raises the charging flow to a temperature approaching the reactor coolant temperature. The flow is then injected into a cold leg of the RCS. Two charging paths are provided from a point downstream of the regenerative HX. A flow path is also provided from the regenerative HX outlet to the pressurizer spray line. An air-operated valve in the spray line is employed to provide auxiliary spray to the vapor space of the pressurizer during plant cooldown. This provides a means of cooling and depressurizing the pressurizer near the end of plant cooldown, when the RCPs, which normally provide the driving head for the pressurizer spray, are not operating. Should the normal means of depressurization be unavailable, a safety-related means of depressurization is provided as discussed in Section 5.4.13 and Appendix 5.4.A.

A portion of the charging flow is directed to the RCPs (nominally 8 gal/min per pump) through a seal water injection filter. The seal water is directed down to a point above the pump shaft bearing and the thermal barrier cooling coil. Here the flow splits, and a portion (nominally 5 gal/min per pump) cools the lower bearing and then enters the RCS through the labyrinth seals and thermal barrier. The remainder of the flow is directed up the pump shaft to the no. 1 seal leakoff. The no. 1 seal leakoff flow discharges to a common manifold, exits from the Containment, and then passes through the seal water return filter and the seal water HX to the suction side of the charging pumps, or by alternate path to the VCT. A very small portion of the seal flow leaks through to the no. 2 seal. A no. 3 seal provides a final barrier to leakage of reactor coolant to the Containment atmosphere. The no. 2 leakoff flow is discharged to the reactor coolant drain tank (RCDT) in the Liquid Waste Processing System (LWPS). The no. 3 seal leakoff flow is discharged to the Containment sump (this leakoff flow consists of reactor makeup water which is injected into the no. 3 seal).

Should the normal charging paths be unavailable, two separate charging paths can be made available by closing the charging pump discharge isolation valves and opening the bypass valves. One path is via charging pump A to RCP seal injection; the other is via charging pump B to normal charging.

The primary purpose of the positive displacement pump is that of hydrotesting the RCS. However, it can also be used to provide RCP seal injection flow and reactor coolant boration capability for the abnormal condition when both centrifugal charging pumps are out of service. During this abnormal operating condition, the flow from the positive displacement pump is directed to the RCPs, where the flow splits, with one portion entering the RCS and the other returning through the seal return lines to the charging pump suction header. In order to maintain proper reactor coolant inventory, the inleakage of water to the RCS must be balanced by bleeding water from the RCS via the excess letdown line.

The excess letdown path is provided from the RCS as an alternate in the event the normal letdown path is inoperable. Reactor coolant can be discharged from a cold leg to flow through the tube side of the excess letdown HX, where it is cooled by CCW. Downstream of the HX, a remote-manual control valve controls the letdown flow. The flow normally joins the no. 1 seal discharge manifold and passes through the seal water return filter and HX to the suction side of the charging pumps. The excess letdown flow can also be directed to the RCDT or directly into the VCT via a spray nozzle. When the normal letdown line is not available, the normal purification path is also not in operation. Therefore, this alternate condition would allow continued power operation for a limited period of time, dependent upon RCS chemistry and activity. The excess letdown flow path is also used to provide additional letdown capability during the final stages of plant heatup. This path removes some of the excess reactor coolant due to expansion of the system as a result of the RCS temperature increase. Should the normal letdown paths be unavailable, a safety-related letdown path via the Reactor Vessel Head Vent System (RVHVS) is provided as discussed in Section 5.4.15 and Appendix 5.4.A. A pressurizer line is provided, between the regenerative heat exchanger and the excess letdown heat exchanger, to equalize the pressure upstream of the regenerative heat exchanger and to avoid hydraulic transients.

Surges in RCS inventory due to load changes are accommodated for the most part in the pressurizer. The VCT provides surge capacity for reactor coolant expansion not accommodated by the pressurizer. If the water level in the VCT exceeds the normal operating range, a proportional controller modulates a three-way valve downstream of the reactor coolant filter to divert a portion of the letdown to the Boron Recycle System (BRS). If the high-level setpoint in the VCT is reached, an alarm is actuated in the control room, and the letdown flow is completely diverted to the BRS.

Low level in the VCT initiates makeup from the Reactor Makeup Control System (RMCS). If the RMCS does not supply sufficient makeup to keep the VCT level from falling to a lower level, a low alarm is actuated. Manual action may correct the situation or, if the level continues to decrease, a low-low level signal from the level channels causes the suction of the charging pumps to be transferred to the refueling water storage tank (RWST).

Should a loss of the RWST or the RMWST occur, the operators can shut down and cool down the unit to residual heat removal (RHR) cut-in via the BATs as a source of makeup water. Figures 9.3.4-3 and 9.3.4-5 depict the flow paths from the BATs to charging pump suction. STPEGS has two BATs per unit, each with a nominal capacity of 33,000 gallons. The minimum capacity is specified in the Technical Requirements Manual. The estimated makeup water usage to take the reactor from hot standby to RHR cut-in conditions is 25,000 gallons.

Therefore, the Technical Requirement inventory of the BATs is sufficient to shut down the unit to RHR conditions.

9.3.4.1.2.2 Reactor Coolant Purification and Chemistry Control System - Reactor coolant water chemistry specifications are given in Table 5.2-4.

pH Control

The pH control chemical employed is lithium hydroxide. This chemical is chosen for its compatibility with the materials and water chemistry of borated water/stainless steel/zirconium/inconel systems. In addition, lithium-7 is produced in the core region due to irradiation of the dissolved boron in the coolant.

The concentration of lithium-7 in the RCS is maintained in the range specified for pH control (Table 5.2-4). If the concentration exceeds this range, as it may in the early stages of a core cycle, one of the cation-bed demineralizers is employed in the letdown line in series operation with a mixed-bed demineralizer. Since the amount of lithium to be removed is small (its buildup can be readily calculated), the flow through the cation-bed demineralizer is not required to be full letdown flow. If the concentration of lithium-7 is below the specified limits, lithium hydroxide can be introduced into the RCS.

Oxygen Control

During reactor startup from the cold condition, hydrazine is employed as an oxygen-scavenging agent. Hydrazine is not employed at any time other than startup from the cold shutdown state.

Dissolved hydrogen is employed to control and scavenge oxygen produced due to radiolysis of water in the core region. Sufficient partial pressure of hydrogen is maintained in the VCT such that the specified equilibrium concentration of hydrogen is maintained in the reactor coolant. A pressure control valve maintains a minimum pressure of 15 to 20 psig in the vapor space of the VCT. This valve can be adjusted to provide the correct equilibrium hydrogen concentration (Table 5.2-4). Hydrogen is supplied from the hydrogen manifold in the PGDS.

Zinc Addition

A soluble zinc compound may be added to the reactor coolant as a means to reduce radiation fields within the primary system and to reduce primary water stress corrosion cracking of Inconel-600 components. The zinc used may be either natural zinc or zinc depleted of ^{64}Zn. When used, the maximum steady-state target system zinc concentration is 40 ppb with maximum short-term zinc transient concentrations limited to 80 ppb.

Reactor Coolant Purification

Mixed-bed demineralizers are provided in the letdown line to provide cleanup of the letdown flow. The demineralizers remove ionic corrosion products and certain fission products and zinc acetate during periods of zinc addition. One demineralizer is in continuous service and can be supplemented intermittently by the cation-bed demineralizers, if necessary, for additional purification. The cation resin principally removes cesium and lithium isotopes from the purification flow. The second mixed-bed demineralizer serves as a standby unit for use if the operating demineralizer becomes exhausted during operation.

A further cleanup feature is provided for use during RHR operations. A remote-operated valve admits a bypass flow from the RHRS into the letdown line at a point upstream of the letdown HX. A reactor coolant purification pump, located upstream of the letdown HX and capable of 450 gal/min flow, is provided for use when the inlet pressure from the RHRS is below 400 psig. The flow passes through the HX and then passes through two mixed-bed demineralizers, the two cation-bed demineralizers, and the two reactor coolant filters (each set of components is operated in parallel to accommodate the high purification flow rates). A second spray nozzle is provided in the VCT to assist in handling the 450-gal/min flow when needed. The VCT atmosphere at this time is nitrogen if the shutdown is in preparation for opening the RCS. The fluid is then returned to the RCS via the normal charging route or the RHRS.

Filters are provided at various locations to ensure filtration of particulate and resin fines and to protect the seals on the RCPs.

Fission gases are removed from the reactor coolant by continuous purging of the VCT to the GWPS.

Concentrated Boric Acid Purification

Concentrated boric acid purity is maintained by the Reactor Coolant Purity Control Subsystem (RCPCS) to prevent the ingress of impurities into the reactor coolant from the concentrated boric acid flows. The impurities of primary importance are aluminum, calcium, magnesium, and silica.

The concentrated boric acid purification is performed by the use of a concentrated boric acid polishing demineralizer and polishing filter. A bypass line downstream of the boric acid filter diverts flow from the boric acid transfer pumps to the concentrated boric acid polishing demineralizer and then through the concentrated boric acid polishing filter before being routed back to the boric acid tanks. A portion of this flow to the concentrated boric acid polishing demineralizer is diverted through the concentrated boric acid sample cooler and through a turbidity meter before being routed back to the BATs. Operation is controlled manually by actuation of the two remote-manual isolation valves in the bypass line to the concentrated boric acid polishing demineralizer. A low-low level signal from either of the two boric acid tanks blocks the opening of these valves.

Provisions are also made to permit processing of the concentrated boric acid solution that has been recycled by the BRS evaporator package. This is done by manually valving the recycle evaporator concentrates effluent to the concentrated boric acid polishing demineralizer rather than sending the effluent directly to the boric acid tanks.

9.3.4.1.2.3 Reactor Makeup Control System - The soluble neutron absorber (boric acid) concentration is controlled by the BTRS and by the RMCS. The RMCS is also used to maintain proper reactor coolant inventory. In addition, for emergency boration and makeup, the capability exists to provide refueling water or 4-weight-percent boric acid directly to the suction of the charging pumps.

The RMCS provides a manually preselected makeup composition to the charging pump suction header or to the VCT. The makeup control functions are those of maintaining desired operating fluid inventory in the VCT and adjusting reactor coolant boron concentration for reactivity control. Reactor makeup water and boric acid solution (4-weight-percent) are blended together in order to achieve the reactor coolant boron concentration needed for use as makeup to maintain VCT inventory, or they can be used separately to change the reactor coolant boron concentration.

A BCMS (Section 7.7) is provided to monitor the boron content of the reactor coolant in the letdown line. The boron concentration is indicated in the main control room.

The boric acid is stored in two BATs. Two boric acid transfer pumps are provided, with one pump normally aligned to provide boric acid to the suction header of the charging pumps and the second pump in reserve. On a demand signal by the reactor makeup controller, the pump starts and delivers boric acid to the suction header of the charging pumps. The pump can also be used to recirculate the boric acid tank fluid.

The portions of the CVCS which normally contain concentrated boric acid solution (4-weight-percent boric acid) are provided with heat tracing to maintain solution temperature at $\geq$65°F.

During reactor operation, changes are made in the reactor coolant boron concentration for the following conditions.

1. Reactor startup - Boron concentration must be decreased from shutdown concentration to achieve criticality.

2. Load follow - Boron concentration must be either increased or decreased to compensate for the xenon transient following a change in load.

3. Fuel burnup - Boron concentration must be decreased to compensate for fuel burnup and the buildup of fission products in the fuel.

4. Cold shutdown - Boron concentration must be increased to the cold shutdown concentration.

The BTRS is normally used to control boron concentration to compensate for xenon transients during load follow operations. Boron thermal regeneration can also be used in conjunction with dilution operations of the RMCS to reduce the amount of effluent to be processed by the BRS.

The reactor makeup water pumps, taking suction from the RMWST, are employed for various makeup and flushing operations throughout the systems. One of these pumps also starts on demand from the reactor makeup controller and provides flow to the suction header of the charging pumps or the VCT through the letdown line and spray nozzle

The RMCS can be set up for the following modes of operation:

1. Automatic Makeup

The "automatic makeup" mode of operation of the RMCS provides blended boric acid solution preset to match the boron concentration in the RCS. Automatic makeup compensates for minor leakage of reactor coolant without causing significant changes in the reactor coolant boron concentration.

Under normal plant operating conditions, the mode selector switch is set in the "automatic makeup" position. This switch position establishes a preset control signal to the total makeup flow controller and establishes positions for the makeup stop valves for automatic makeup. The boric acid flow controller is set to blend to the same concentration of borated water as contained in the RCS. A preset low level signal from the VCT level controller causes the automatic makeup control action to start a reactor makeup water pump and a boric acid transfer pump, open the makeup stop valve to the charging pump suction, and position the boric acid flow control valve and reactor makeup water flow control valve. The flow controllers then blend the makeup stream according to the preset concentration. Makeup addition to the charging pump suction header causes the water level in the VCT to rise. At a preset high level point, the makeup is stopped. This operation may be terminated manually at any time.

If the automatic makeup fails or is not aligned for operation and the tank level continues to decrease, a low level alarm is actuated. Manual action may correct the situation or, if the level continues to decrease, an emergency low level signal opens the stop valves in the refueling water supply line to the charging pumps and closes the stop valves in the VCT outlet line.

2. Dilution

The "dilute" mode of operation permits the addition of a preselected quantity of reactor makeup water at a preselected flow rate to the RCS. The operator sets the mode selector switch to "dilute", positions the total makeup flow controller setpoint at the desired flow rate, sets the total makeup batch integrator to the desired quantity, and initiates system start. This opens the reactor makeup water flow control valve, opens the makeup stop valve to the VCT inlet, and starts a reactor makeup water pump. Excessive rise of the VCT water level is prevented by automatic actuation (by the tank level controller) of a three-way diversion valve which routes the reactor coolant letdown flow to the BRS. When the preset quantity of water has been added, the batch integrator causes makeup to stop. Also, the operation may be terminated manually at any time.

Dilution also can be accomplished by operating the BTRS in the boron storage mode.

3. Alternate Dilution

The "alternate dilute" mode of operation is similar to the dilute mode except a portion of the dilution water flows directly to the charging pump suction and a portion flows into the VCT tank via the spray nozzle and then flows to the charging pump suction. This decreases the delay in diluting the RCS caused by directing dilution water to the VCT.

4. Boration

The "borate" mode of operation permits the addition of a preselected quantity of concentrated boric acid solution at a preselected flow rate to the RCS. The operator sets the mode selection switch to "borate", positions the concentrated boric acid flow controller setpoint at the desired flow rate, sets the concentrated boric acid batch integrator to the desired quantity, and initiates system start. This opens the makeup stop valve to the charging pumps suction, positions the boric acid flow control valve, and starts the selected boric acid transfer. This pump delivers a 4-weight-percent boric acid solution to the charging pumps suction header. The total quantity added in most cases is so small that it has only a minor effect on the VCT level. When the preset quantity of concentrated boric acid solution is added, the batch integrator causes makeup to stop. Also, the operation may be terminated manually at any time.

Boration can also be accomplished by operating the BTRS in the boron release mode.

5. Manual

The "manual" mode of operation permits the addition of a preselected quantity and blend of boric acid solution to the RWST, to the recycle holdup tanks in the BRS, or to some other location via a temporary connection. While in the manual mode of operation, automatic makeup to the RCS is precluded. The discharge flow path must be prepared by opening manual valves in the desired path.

The operator sets the mode selector switch to "manual", positions the boric acid and total makeup flow controllers to the desired flow rates, sets the boric acid and total makeup batch integrators to the desired quantities, and actuates the makeup start switch.

The start switch actuates the boric acid flow control valve and the reactor makeup water flow control valve and starts the preselected reactor makeup water pump and boric acid transfer pump.

When the preset quantities of boric acid and reactor makeup water have been added, the batch integrators cause makeup to stop. This operation may be stopped manually by actuating the makeup stop switch.

If either batch integrator is satisfied before the other has recorded its required total, the pump and valve associated with the integrator which has been satisfied terminates flow. The flow controlled by the other integrator continues until that integrator is satisfied. In the manual mode, the boric acid flow is terminated first to prevent piping systems from remaining filled with 4-weight-percent boric acid solution.

The quantities of boric acid and reactor makeup water injected are totalized by the batch counters, and the flow rates are recorded on strip recorders. Deviation alarms sound for both boric acid and reactor makeup water if flow rates deviate from setpoints.

Additionally, manual operation of the boric acid transfer pumps, reactor makeup water pumps, and the system flow control valves will allow makeup to the RCS or boration or dilution of the RCS without the use of the mode selector switch and associated controls.

9.3.4.1.2.4 Boron Thermal Regeneration System - Downstream of the mixed-bed demineralizers, the letdown flow can be diverted to the BTRS, where part or all of the letdown flow can be treated when boron concentration changes are desired for load follow. After processing, the flow is returned to a point upstream of the reactor coolant filter.

The BCMS (Section 7.7) can be used to monitor the boron content in the letdown stream before it is diverted to the BTRS for processing; or it can monitor the adjusted boron content of the letdown stream after it has been treated by the thermal regeneration process.

Storage and release of boron during load follow operation is determined by the temperature of fluid entering the thermal regeneration demineralizers. A chiller unit and a group of HXs are employed to provide the desired fluid temperatures at the demineralizer inlets for either storage or release operation of the system.

The flow path through the BTRS is different for the boron storage and the boron release operations. During boron storage, the letdown stream enters the moderating HX and from there passes through the letdown chiller HX. These two HXs cool the letdown stream prior to its entering the demineralizers. The letdown reheat HX is valved out on the tube side and performs no function during boron storage operations. The temperature of the letdown stream at the point of entry to the demineralizers is controlled automatically by the temperature control valve, which controls the shell side flow to the letdown chiller HX. After passing through the demineralizers, the letdown enters the moderating HX shell side, where it is heated by the incoming letdown stream before returning to the letdown path and continuing through the reactor coolant filter to the VCT.

The BTRS is provided with its own chilled water loop. Water from the chiller surge tank is pumped via a chiller pump to the BTRS chiller. The chilled water then passes through the letdown chiller HX to cool the letdown and then returns to the chiller surge tank. The chilled water is demineralized water. The surge tank is provided with a nitrogen blanket (see Table 9.3-10 for parameters). Chemicals (e.g., pH modifiers or biocides) may be added as prescribed in good industry practices.

Therefore, for boron storage, a decrease in the boric acid concentration in the reactor coolant is accomplished by sending the letdown flow at relatively low temperatures to the thermal regeneration demineralizers. The resin, which was depleted of boron at high temperature during a prior boron release operation, is now capable of storing boron from the low-temperature letdown stream. Reactor coolant with a decreased concentration of boric acid leaves the demineralizers and is directed to the RCS via the charging system.

During the boron release operation, the letdown stream enters the moderating HX tube side, bypasses the letdown chiller HX, and passes through the shell side of the letdown reheat HX. The moderating and letdown reheat HXs heat the letdown stream prior to its entering the resin beds. The temperature of the letdown at the point of entry to the demineralizers is controlled automatically by a temperature control valve, which controls the flow rate on the tube side of the letdown reheat HX. After passing through the demineralizers, the letdown stream enters the shell side of the moderating HX, passes through the letdown chiller HX, and then returns to the letdown path and goes to the VCT. The temperature of the letdown stream entering the VCT is controlled automatically by adjusting the shell side flow rate on the letdown chiller HX. Thus, for boron release, an increase in the boric acid concentration in the reactor coolant is accomplished by sending the letdown flow at relatively high temperatures to the thermal regeneration demineralizers. The water flowing through the demineralizers now absorbs boron which is released by the resin in the demineralizers. The boron was stored by the resin at low temperature during a previous boron storage operation. The boron-enriched reactor coolant is returned to the RCS via the charging system.

Although the BTRS is primarily designed to compensate for xenon transients occurring during load follow, it can also be used to handle boron swings far in excess of the design capacity of the demineralizers. During startup dilution, for example, the resin beds are first saturated, then washed off to the BRS, then again saturated and washed off. This operation continues until the desired dilution in the RCS is obtained.

As an additional function, a thermal regeneration demineralizer can be used as a deborating demineralizer, which would be used to dilute the RCS down to very low boron concentrations towards the end of a core cycle. To make such a bed effective, the effluent concentration from the bed must be kept very low, close to zero ppm boron. This low effluent concentration can be achieved by using fresh resin. Use of fresh resin can be coupled with the normal replacement cycle of the resin, one resin bed being replaced during each core cycle.

9.3.4.1.2.5 Component Description - A summary of principal component design parameters is given in Table 9.3-10 and safety classifications and design codes are given in Section 3.2.

All CVCS piping that handles radioactive liquid is austenitic stainless steel. All piping joints and connections are welded, except where flanged connections are required to facilitate equipment removal for maintenance and hydrostatic testing.

Centrifugal Charging Pumps

Two single-speed, horizontal, centrifugal charging pumps are supplied to inject coolant into the RCS. All parts in contact with the reactor coolant are fabricated of austenitic stainless steel or other material of adequate corrosion resistance.

There is a minimum-flow recirculation line to protect the centrifugal charging pumps (CCPs) from a low-flow or closed -discharge-valve condition. A flow monitor is provided on the discharge line of each centrifugal charging pump. Local indication is provided, and when the low-flow setpoint is reached, the control valve in the minimum-flow recirculation line is automatically opened.

Charging flow rate is regulated by a modulating control valve located in the discharge header of the charging pumps. This valve is controlled by a pressurizer-level signal. RCP seal water injection flow is controlled by a remote-manual control valve. During normal operation, only one centrifugal pump is required to supply the charging line plus the RCP seal water injection flow.

Positive Displacement Pump

The positive displacement pump is used primarily for hydrotesting the RCS but is capable of providing sufficient flow for RCP seal injection during the abnormal condition when both CCPS are inoperable.

The pump is a positive displacement, single-speed type. All parts of the pump in contact with reactor coolant are constructed of austenitic stainless steel.

The pump is supplied with a suction pulsation dampener and a discharge pulsation dampener to alleviate pressure waves in the associated piping.

The suction pulsation dampener reduces suction pulsation to less than (4 psi peak-to-peak. This dampener does not have a bladder and is not gas charged and therefore reduces the possibility of gas injection into the charging pump suction. A vent connection is provided for the removal of any free gas in the system.

The discharge pulsation dampener reduces discharge pressure pulsation to (50 psi peak-to-peak.

The positive displacement pump is supplied with backup power from a non-Class 1E diesel generator.

Boric Acid Transfer Pumps

Two canned motor pumps are supplied per unit. One pump is normally aligned to supply boric acid to the suction header of the charging pumps, while the second serves as a standby. Manual or automatic initiation of the Reactor Coolant Makeup System starts the one pump to provide normal makeup of boric acid solution to the suction header of the charging pumps. Miniflow from this pump flows back to the associated boric acid tank and helps maintain thermal equilibrium. The standby pump can be used intermittently to circulate boric acid solution through the other tank to maintain thermal equilibrium in this part of the system. Emergency boration, supplying 4-weight-percent boric acid solution directly to the suction of the charging pumps, can be accomplished by manually starting either or both pumps, and by opening motor-operated valve (MOV) XCV 0218 at the main control board. The transfer pumps also function to transfer boric acid solution from the batching tank to the boric acid tanks.

The pumps are heat traced to prevent crystallation of the boric acid solution. The parts in contact with the solution are of austenitic stainless steel.

Chiller Pumps

Two centrifugal pumps circulate the water through the chilled water loop in the BTRS. One pump normally is operated, with the second serving as a standby.

Reactor Coolant Purification Pump

This centrifugal pump can circulate reactor coolant from the RHRS through the CVCS for purification during a cold shutdown. This pump, together with the parallel operation of both mixed-bed demineralizers, both cation-bed demineralizers, and both reactor coolant filters, permits the CVCS to process a purification flow during plant cooldown and cold shutdown that is greater than the maximum purification flow that can be achieved via the letdown orifices when the reactor is at power or in the hot shutdown condition.

Regenerative Heat Exchanger

The regenerative HX is designed to recover heat from the letdown flow by reheating the charging flow, which reduces thermal effects on the charging penetrations into the reactor coolant loop piping.

The letdown stream flows through the shell of the regenerative HX, and the charging stream flows through the tubes. The unit is constructed of austenitic stainless steel and is of all-welded construction.

The temperatures of both outlet streams from the HX are monitored, with indication given in the control room. A high-temperature alarm is actuated on the main control board if the temperature of the letdown stream exceeds desired limits.

Letdown Heat Exchanger

The letdown HX cools the letdown stream to the operating temperature of the mixed-bed demineralizers. Reactor coolant flows through the tube side of the HX while CCW flows through the shell side. The surfaces in contact with the reactor coolant are austenitic stainless steel, and the shell is carbon steel.

The low-pressure letdown valve, located downstream of the HX, maintains the pressure of the letdown flow upstream of the HX in a range sufficiently high to prevent two-phase flow. Pressure indication and high-pressure alarm are provided on the main control board.

The letdown temperature control indicates and controls the temperature of the letdown flow exiting from the letdown HX. A temperature sensor, which is part of the CVCS, provides input to the controller in the CCWS. The exit temperature of the letdown stream is thus controlled by regulating the CCW flow through the letdown HX. Temperature indication is provided on the main control board. If the outlet temperature from the HX is excessive, a high-temperature alarm is actuated, and a temperature-controlled valve diverts the letdown directly to the VCT via the reactor coolant filter, bypassing the mixed-bed and cation demineralizer, as well as the BTRS.

The outlet temperature from the shell side of the HX is allowed to vary over an acceptable range compatible with the equipment design parameters and the required performance of the HX in reducing letdown stream temperature.

Excess Letdown Heat Exchanger

The excess letdown HX cools reactor coolant letdown flow. This letdown flow rate is equivalent to the portion of the nominal seal injection flow which flows into the RCS through the RCP labyrinth seals.

The excess letdown HX can be employed when normal letdown is temporarily out of service to maintain the reactor in operation or it can be used to supplement maximum letdown during the final stages of heatup. The letdown flows through the tube side of the unit, and CCW is circulated through the shell. The surfaces in contact with reactor coolant are austenitic stainless steel and the shell is carbon steel. The tube joints are welded.

A temperature detector measures the temperature of the excess letdown flow downstream of the excess letdown HX. Temperature indication and high-temperature alarm are provided on the main control board.

A pressure sensor indicates the pressure of the excess letdown flow downstream of the excess letdown HX and excess letdown control valve. Pressure indication is provided on the main control board.

Seal Water Heat Exchanger

The seal water HX is designed to cool fluid from three sources: RCP seal leakage from seal no. 1, reactor coolant discharged from the excess letdown HX, and miniflow from a centrifugal charging pump. Reactor coolant flows through the tube side of the HX, and CCW is circulated through the shell. The design flow rate through the tube side is equal to the sum of the nominal excess letdown flow, maximum design RCP seal leakage, and miniflow from one centrifugal charging pump. The unit is designed to cool the above flow to the temperature normally maintained in the VCT. The surfaces in contact with reactor coolant are austenitic stainless steel and the shell is carbon steel.

Moderating Heat Exchanger

The moderating HX operates as a regenerative HX between incoming and outgoing streams to and from the thermal regeneration demineralizers.

The incoming letdown flow enters the tube side of the moderating HX. The shell side fluid, which comes directly from the thermal regeneration demineralizers, enters at low temperature during boron storage and high temperature during boron release.

Letdown Chiller Heat Exchanger

During the boron storage operation, the process stream enters the tube side of the letdown chiller HX after leaving the tube side of the moderating HX.

The letdown chiller HX cools the process stream to allow the thermal regeneration demineralizers to remove boron from the coolant. The desired cooling capacity is adjusted by controlling the chilled water flow rate passed through the shell side of the HX.

The letdown chiller HX is also used during the boron release operation to cool the liquid leaving the thermal regeneration demineralizers to ensure that its temperature does not exceed that of normal letdown to the VCT.

Letdown Reheat Heat Exchanger

The letdown reheat HX is used only during boron release operations, and it is used then to heat the process stream. Water used for heating is diverted from the letdown line upstream of the letdown HX, passed through the tube side of the letdown reheat HX, and then returned to the letdown stream upstream of the letdown HX.

Concentrated Boric Acid Sample Cooler

The concentrated boric acid sample cooler cools the concentrated boric acid flow from the boric acid filter or from the BRS evaporator package prior to reaching the turbidity meter. Boric acid flows through the tube side and CCW flows through the shell.

Volume Control Tank

The VCT provides surge capacity for part of the reactor coolant expansion volume not accommodated by the pressurizer. When the level in the tank reaches the high-level setpoint, the remainder of the expansion volume is accommodated by diversion of the letdown stream to the BRS.

The VCT also serves as a head tank for the charging pumps. Hydrogen is introduced into the reactor coolant via a hydrogen gas overpressure maintained in the VCT. The VCT may be used for degassing the reactor coolant. Alternatively the reactor coolant may be degassed by use of a chemical degas methodology.

A spray nozzle located inside the tank on the letdown line provides liquid to gas contact between the incoming fluid and the hydrogen atmosphere in the tank.

Hydrogen (from the hydrogen manifold in the PGDS) is supplied to the VCT, while a remotely operated vent valve, discharging to the GWPS, permits continuous removal of gaseous fission products which are stripped from the reactor coolant and collected in this tank. Relief protection, gas space sampling, and nitrogen purge connections are also provided. The tank can also accept the seal water return flow from the RCPs, although this flow normally goes directly to the suction of the charging pumps.

VCT pressure is monitored with indication given in the control room. Alarm is actuated in the control room for high- and low-pressure conditions. The VCT pressure control valve is automatically closed by the low-pressure signal.

Two level channels govern the water inventory in the VCT. Level indication with a low alarm is provided on the main control board for one controller, and local level indication with a high and low alarm on the main control board is provided for the other controller.

If the VCT level rises above the normal operating range, one level channel provides an analog signal to the proportional controller that modulates the three-way valve downstream of the reactor coolant filter to maintain the VCT level within the normal operating band. The three-way valve can split letdown flow so that a portion goes to the BRS and a portion to the VCT. The controller would operate in this fashion during a dilution operation when reactor makeup water is being fed to the VCT from the RMCS.

If the modulating function of the channel fails and the VCT level continues to rise, the high-level alarm will alert the operator to the malfunction, and the full letdown flow will be automatically diverted by the backup level channel to the BRS.

During normal power operation, a low level in the VCT initiates auto-makeup, which injects a preselected blend of boric acid solution and reactor makeup water into the charging pump suction header. When VCT level is restored to normal, auto-makeup stops.

If the automatic makeup fails or is not aligned for operation and the tank level continues to decrease, a low level alarm is actuated. Manual action may correct the situation or, if the level continues to decrease, a low-low signal from the level channels opens the stop valves in the refueling water supply line and closes the stop valves in the VCT outlet.

Boric Acid Tanks

Two BATs are provided. The combined capacity of the tanks provides sufficient boric acid for refueling, plus enough additional boric acid for one cold shutdown immediately following refueling with the most reactive control rod withdrawn. Each tank contains an operating margin sufficient to avoid loss of boric acid transfer pump suction. The concentration of boric acid solution is maintained between 4- and 4.4-weight-percent. Periodic manual sampling and corrective action, if necessary, assure that these limits are maintained. As a consequence, measured amounts of boric acid solution can be delivered to the reactor coolant to control the boron concentration.

A temperature sensor provides temperature measurement of each tank's contents. Temperature indication as well as high- and low-temperature alarms are provided on the main control board.

Two level detectors indicate the level in each BAT. Level indication with high-, low-low-, and empty-level alarms is provided on the main control board. The high alarm indicates that the tank may soon overflow. The low-low alarm is set to indicate the minimum level of boric acid in the tank to ensure that sufficient boric acid is available for a cold shutdown with one stuck rod. The empty-level alarm is set to give warnings of loss of pump suction.

Batching Tank

The batching tank is used for mixing a makeup supply of boric acid solution for transfer to the BATs.

A local sampling point is provided for verifying the solution concentration prior to transferring it out of the tank. The tank is provided with an agitator to improve mixing during batching operations and a steam jacket for heating the boric acid solution.

Chemical Mixing Tanks

The primary use of the chemical mixing tank is in the preparation of caustic solutions for pH control and hydrazine solution for oxygen scavenging.

Chiller Surge Tank

The chiller surge tank handles the thermal expansion and contraction of the water in the chiller loop. The surge volume in the tank also acts as a thermal buffer for the chiller. In addition, the chiller surge tank provides a hold up should there be a leak in the chiller. The fluid level in the tank is monitored, with level indication and high- and low-level alarms provided on the main control board. The tank is provided with a nitrogen blanket and a chemical addition connection.

Mixed-Bed Demineralizers

Two flushable mixed-bed demineralizers assist in maintaining reactor coolant purity. A lithium-form cation resin and hydroxyl-form anion resin are charged into the demineralizers. The anion resin is converted to the borate form in operation. Both types of resin remove fission and corrosion products. The resin bed is designed to reduce the concentration of ionic isotopes in the purification stream, except for cesium, yttrium, and molybdenum, by a minimum factor of 10.

Each demineralizer has more than sufficient capacity for one core cycle with 1 percent of the rated core thermal power being generated by defective fuel rods. One demineralizer is normally in service with the other on standby, except when both demineralizers are used to accommodate the high purification flow experienced when reactor coolant is delivered from the RHRS to the letdown line for cleanup during plant cooldown or cold shutdown.

A temperature sensor monitors the temperature of the letdown flow downstream of the letdown HX, and if the letdown temperature exceeds the maximum allowable resin operating temperature (approximately 140°F), a three-way valve is automatically actuated to bypass the flow around the demineralizers. Temperature indication and high alarm are provided on the main control board. The air-operated three-way valve failure mode directs flow to the VCT via the reactor coolant filter.

Cation-Bed Demineralizers

Two flushable demineralizers with cation resin in the hydrogen form are located downstream of the mixed-bed demineralizers. One demineralizer is used intermittently to control the concentration of lithium-7 which builds up in the coolant form the B-10 $\rightarrow$ (n, a) $\rightarrow$ Li-7 reaction. Each demineralizer also has sufficient capacity to maintain the cesium-137 concentration in the coolant below 1.0 μCi/cc with 1 percent defective fuel. The resin bed is designed to reduce the concentration of ionic isotopes, particularly cesium, yttrium, and molybdenum, by a minimum factor of 10.

Each demineralizer has more than sufficient capacity for one core cycle with 1 percent of the rated core thermal power being generated by defective fuel rods. Only one demineralizer is normally utilized, except when both demineralizers are used to accommodate the high purification flow experienced when reactor coolant is delivered from the RHRS to the letdown line for cleanup during plant cooldown or cold shutdown.

Thermal Regeneration Demineralizers

The function of the thermal regeneration demineralizers is to store the total amount of boron that must be removed from the RCS to accomplish the required dilution during a load cycle in order to compensate for xenon buildup resulting from a decreased power level. Furthermore, the deminerlaizers must be able to release the previously stored boron to accomplish the required boration of the reactor coolant during the load cycle in order to compensate for a decrease in xenon concentration resulting from an increased power level.

The thermally reversible ion storage capacity of the resin applies only to borate ions. The capacity of the resin to store other ions is not thermally reversible. Thus, during boration, when borate ions are released by the resin, there is no corresponding release of the ionic fission and corrosion products stored on the resin.

The thermal regeneration demineralizer resin capacity is directly proportional to the solution boron concentration and inversely proportional to the temperature. Further, the differences in capacity as a function of both boron concentration and temperature are reversible. For the 50°F to 140°F temperature cycle, this reversible capacity varies from the beginning of a core cycle to the end of core life by a factor of about 2.

The demineralizers can accept flow in either direction. The flow direction during boron storage is therefore always opposite to that during release. This provides much faster response when the beds are switched from storage to release and vice versa than would be the case if the demineralizers could accept flow in only one direction.

Temperature instrumentation is provided upstream of the thermal regeneration demineralizers to control the temperature of the process flow. During boron storage operations, it controls the flow through the shell side of the letdown chiller HX to maintain the process flow at 50°F as it enters the demineralizers. During boron release operations, it controls the flow through the tube side of the letdown reheat HX to maintain the process at 140°F as it enters the demineralizers. Temperature indication and a high temperature alarm are provided on the main control board.

An additional temperature instrument is provided to protect the demineralizer resins from a high temperature condition. On reaching the high temperature setpoint, an alarm is sounded on the main control board, and the letdown flow is diverted to the VCT from a point upstream of the mixed-bed demineralizers.

Failure of the temperature controls, resulting in hot water flow to the demineralizers, would result in a release of boron stored on the resin, with a resulting increase in reactor coolant boron concentration and increased margin for shutdown. If the temperature of the resin rises significantly above 140°F, the number of ion storage sites will gradually decrease, thus reducing the capability of the resin to remove boron from the process stream. Degradation of ion removal capability will occur for temperatures of approximately 160°F and above. The extent of degradation and the rate at which it will occur depend upon the temperature experienced by the resin and the length of time that the resin experiences this elevated temperature.

Failure of the temperature control system resulting in cold water flow to the demineralizers would result in storage of boron on the resin and reduction of the reactor coolant boron concentration. The amount of reduction in reactor coolant boron concentration is limited by the capacity of the resin to remove boron from the water. As the boron concentration is reduced, the control rods would be driven in to the core to maintain power level. If the rods were to reach the shutdown limit setpoint, an alarm would be actuated, informing the operator that emergency boration of the RCS was necessary in order to maintain capability of shutting the reactor down with control rods alone.

Concentrated Boric Acid Polishing Demineralizer

The concentrated boric acid polishing demineralizer removes cationic impurities and some suspended solids from the following concentrated boric acid streams: the BATs (fresh acid), the BRS evaporator (recycled acid), and the boric acid batching tank.

Reactor Coolant Filters

Two reactor coolant filters are located in parallel in the letdown line upstream of the VCT. The filters collect resin fines and particulates from the letdown stream. Only one filter is normally in service, except when both filters are used to accommodate the high purification flow experienced when reactor coolant from the RHRS is delivered to the letdown line for cleanup during plant cooldown or cold shutdown.

Two local pressure indicators are provided to show the pressures upstream and downstream of the reactor coolant filter and thus provide filter differential pressure.

Seal Water Injection Filters

Two seal water injection filters are located in parallel in a common line to the RCP seals; they collect particulate matter that could be harmful to the seal faces. Each filter is sized to accept flow in excess of the normal seal water flow requirements.

A differential pressure indicator monitors the pressure drop across each seal water injection filter and gives local indication with high differential pressure alarm on the main control board.

Letdown Filters

Two filters are located in parallel upstream of the mixed-bed demineralizers. The filters collect particulates from the letdown stream. One or both of the letdown filters may be used as needed for purification. If the filters are not needed, then the filter bypass line is used. Both filters may be used to accommodate the high purification flow experienced when reactor coolant from the RHRS is delivered to the letdown line for cleanup during plant cooldown or cold shutdown.

Two local pressure indicators are provided to show the pressures upstream and downstream of each letdown filter and thus provided filter differential pressure.

Seal Water Return Filter

This filter collects particulates from the RCP seal water return and from the excess letdown flow. The filter is designed to pass the sum of the excess letdown flow and the maximum design leakage from all RCPs.

Two local pressure indicators are provided to show the pressures upstream and downstream of the filter and thus provide differential pressure across the filter.

Boric Acid Filter

The boric acid filter collects particulates from the boric acid solution being pumped from the BATs by the boric acid transfer pumps. The filter is designed to pass the design flow of two boric acid transfer pumps operating simultaneously.

Local pressure indicators indicate the pressure upstream and downstream of the boric acid filter and thus provide filter differential pressure.

Concentrated Boric Acid Polishing Filter

The concentrated boric acid polishing filter removes suspended solids from the fresh boric acid from the BATs or recycled boric acid from the BRS evaporator, or fresh boric acid from the boric acid batching tank.

Letdown Orifices

Three letdown orifices are provided to reduce the letdown pressure from reactor conditions and to control the flow of reactor coolant leaving the RCS. The orifices are placed into or out of service by remote operation of their respective isolation valves. One orifice is designed for normal letdown flow, with the other two serving as standbys. One or both of the standby orifices may be used in parallel with the normally operating orifice for either flow control when the RCS pressure is less than normal or greater letdown flow during maximum purification or heatup. Each orifice consists of an assembly which provides for permanent pressure loss without recovery, and is made of austenitic stainless steel.

A flow monitor provides indication in the control room of the letdown flow rate, with high and low alarms to indicate unusually high or low flows.

A low-pressure letdown controller located downstream of the letdown HX controls the pressure upstream of the letdown HX to prevent flashing of the letdown liquid. Pressure indication and high-pressure alarm are provided on the main control board.

Chiller

The chiller is located in a chilled water loop containing a surge tank, chiller pumps, the letdown chiller HX, piping, valves, and controls.

The purpose of the chiller is two-fold:

1. To cool down the process stream during storage of boron on the resin.

2. To maintain an outlet temperature from the BTRS at or below 115°F during release of boron.

Valves

Basic material of construction is stainless steel for all valves which handle radioactive liquid or boric acid solutions.

Valve leakage to the atmosphere is minimized by employing valves with the desired features of reliability and good performance. Where practical, hermetically sealed valves (e.g.: packless metal diaphragm, bellows seal, etc.) are employed.

All packed valves which are larger than 2 in. (supplied by Westinghouse under NSSS scope) and which are designated for radioactive services are provided with stuffing box and lantern leakoff connections. The packing gland leak-off connections on valves provided with "live load" packing are cut and capped. All control (modulating) and three-way valves either are provided with stuffing box and leakoff connections or are totally enclosed. Leakage to the atmosphere is essentially zero for these valves.

Relief valves are provided for lines and components that might be pressurized above design by improper operation or component malfunction.

1. Charging Line Downstream of Regenerative Heat Exchanger

If the charging side of the regenerative HX is isolated while the hot letdown flow continues at its maximum rate, the volumetric expansion of coolant on the charging side of the HX is relieved to the RCS through a spring-loaded check valve.

2. Letdown Line Downstream of Letdown Orifices

The pressure relief valve downstream of the letdown orifices protects the low-pressure piping and the letdown HX from overpressure when the low pressure piping is isolated. The capacity of the relief valve is equal to the maximum flow rate through all letdown orifices. The valve set pressure is equal to the design pressure of the letdown HX tube side.

3. Letdown Line Downstream of Low-Pressure Letdown Valve

The pressure relief valve downstream of the low-pressure letdown valve protects the low-pressure piping and equipment from overpressure when this section of the system is isolated. The overpressure may result from leakage through the low-pressure letdown valve. The capacity of the relief valve is greater than the maximum flow through the RHRS purification line, which is greater than the maximum flow rate through all letdown orifices. The valve set pressure is equal to the design pressure of the demineralizers.

4. Volume Control Tank

The relief valve on the VCT permits the tank to be designed for a lower pressure than the upstream equipment. This valve has a capacity greater than the summation of the following items: maximum RHRS purification flow, normal seal water return, excess letdown, and nominal flow from one reactor makeup water pump. The valve set pressure equals the design pressure of the VCT.

5. Seal Water Return Line (Inside Containment)

This relief valve is designed to relieve overpressurization in the seal water return piping inside the Containment if the motor-operated isolation valve is closed. The valve is designed to relieve the total leakoff flow the no. 1 seals of the RCPs plus the design excess letdown flow. The valve is set to relieve at the design pressure of the piping.

6. Seal Water Return Line (Charging Pumps Bypass Flow)

This relief valve protects the seal water HX and its associated piping from overpressurization. If either of the isolation valves for the HX is closed and if the bypass line is closed, the piping would be overpressurized by the miniflow from the centrifugal charging pumps. The valve is sized to handle the miniflow from the centrifugal charging pumps. The valve is set to relieve at the design pressure of the HX.

7. Positive Displacement Pump Discharge

The pressure relief valve on the positive displacement pump discharge line relieves the rated pumping capacity if the pump is started with the discharge isolation valve closed. The set pressure of the valve is equal to the design pressure of the pump discharge piping.

8. Letdown Reheat Heat Exchanger

The relief valve is located on the piping leading from the shell side of the HX. If the shell side were isolated while flow was maintained in the tube side, overpressurization could occur. The valve is set to relieve at the design pressure of the HX shell side.

9. Letdown Chiller Heat Exchanger

The relief valve is located on the piping leading from the shell side of the HX. If the shell side were isolated while flow was maintained in the tube side, overpressurization could occur. The valve is set to relieve at the design pressure of the HX shell side.

10. Steam Line to Batching Tank

The relief valve on the steam line to the batching tank protects the low-pressure piping and batching tank heating jacket from overpressure when the condensate return line is isolated. The capacity of relief valve equals the maximum expected steam inlet flow. The set pressure equals the design pressure of the heating jacket.

11. Reactor Coolant Purification Pump Discharge

This relief valve protects the reactor coolant purification pump and piping from overpressure in the event the pump is started with high suction pressure. The capacity of the valve exceeds the expected pump flow. The set pressure is equal to pump design pressure.
Piping

The CVCS piping that handles radioactive liquid is austenitic stainless steel. The piping joints and connections are welded, except where flanged connections are required to facilitate equipment removal for maintenance and hydrostatic testing.

9.3.4.1.2.6 System Operation -

Reactor Startup

Reactor startup is defined as the operations which bring the reactor from cold shutdown to normal operating temperature and pressure.

It is assumed that:

1. Normal RHR is in progress

2. RCS boron concentration is at the cold shutdown concentration.

3. The RMCS is set to provide makeup at the cold shutdown concentration.

4. The RCS is either water-solid or drained to minimum level for the purpose of refueling or maintenance. If the RCS is water-solid, system pressure is maintained by operation of a charging pump and controlled by the low-pressure letdown valve in the letdown line (letdown is achieved via the RHRS).

5. The charging and letdown lines of the CVCS are filled with coolant at the cold shutdown boron concentration. The letdown orifice isolation valves are closed.

If the RCS requires filling and venting, two alternate procedures for filling, venting and drawing the pressurizer bubble may be used. With the first procedure RCS is filled at atmospheric pressure and air and noncondensibles from the system are removed by operating the reactor coolant pumps. The second procedure utilizes vacuum venting of the RCS while filling the system to remove the air and the noncondensibles from the system.

A) RCS fill and vent at atmospheric pressure:

1. One charging pump is started, which provides blended flow from the RMCS at the cold shutdown boron concentration.

2. The vents on the head of the reactor vessel and pressurizer are opened,

3. The RCS is filled and the vents closed.

The system pressure is raised by using the charging pump and is controlled by the low-pressure letdown valve. When the system pressure is adequate for operation of the RCPs, seal water flow to the pumps is established, and the pumps are operated and vented sequentially until all gases are cleared from the system. Final venting takes place at the pressurizer.

After filling and venting operations are completed, charging and letdown flows are established. The pressurizer heaters are then energized. Steam bubble formation in the pressurizer is accomplished by increasing the letdown flow above the charging flow.

B) RCS vacuum venting and filling:

The RCS is drained and water level maintained at mid-loop. RCP seal injection is established to prevent air inleakage through the seals during vacuum venting. The pressurizer relief tank level is maintained above sparger level to prevent air inleakage from the interconnecting system. The pressurizer spray valves are opened to provide an airflow path from the RCS loops to the top of the pressurizer. The RCS manual head vent isolation valves are closed. An air flow path is established between the reactor head space and top of the pressurizer.

A vacuum vent system is connected to the pressurizer vent line to establish a vacuum of approximately 21"Hg. This is expected to remove approximately 80% of the air from the RCS. The RCS level is then raised gradually by using normal charging or the Safety Injection system while vacuum is maintained. When the RCS level reaches the top of the reactor head, the head is isolated from the pressurizer. The RCS level is then raised to approximately pressurizer mid-level. The pressurizer vent valves are closed and the vacuum system is disconnected. A bubble in the pressurizer is drawn by energizing the pressurizer heaters. Pressurizer level is maintained by regulating the charging and low pressure letdown flows.

After the pressurizer bubble has been formed, the RCPs are started to heat up the system. When the pressurizer water level reaches the no-load programmed setpoint, the pressurizer level control is shifted to control the charging flow to maintain programmed level. The RHRS is then isolated from the RCS, and the normal letdown path is established. The pressurizer heaters are then used to increase RCS pressure.

The reactor coolant boron concentration is now reduced either by operating the RMCS in the dilute mode or by operating the BTRS in the boron storage mode and, when the resin beds are saturated, washing off the beds to the BRS. The reactor coolant boron concentration is corrected to the point where the control rods may be withdrawn and criticality achieved. Nuclear heatup may then proceed with corresponding manual adjustment of the reactor coolant boron concentration to balance the temperature coefficient effects and maintain the control rods within their operating range. During heatup, the appropriate combination of letdown orifices is used to provide necessary letdown flow.

Prior to or during the heating process, the CVCS is employed to obtain the correct chemical properties in the RCS. The RMCS is operated on a continuing basis to ensure correct control rod position. The required control of reactor coolant chemistry parameters such as pH and dissolved oxygen is achieved by performing chemical additions. Hydrogen overpressure is established in the VCT to assure appropriate hydrogen concentration in the reactor coolant.

<u>Power Generation and Hot Standby Operation</u>

1. Base Load

At a constant power level, the rates of charging and letdown are dictated by the requirements for seal water to the RCPs and the normal purification of the RCS. One charging pump is employed, and charging flow is controlled automatically from pressurizer level. The only adjustments in boron concentration necessary are those to compensate for core burnup. These adjustments are made at infrequent intervals to maintain the control groups within their allowable limits. Rapid variations in power demand are accommodated for by automatic control rod movement. If variations in power level occur, and the new power level is sustained for long periods, some adjustments in boron concentration may be necessary to maintain the control groups within their maneuvering band.

During normal operation, normal letdown flow is maintained, and one mixed-bed demineralizer is in service. Reactor coolant samples are taken periodically to check boron concentration, water quality, pH, and activity level. The charging flow to the RCS is controlled automatically by the pressurizer level control signal through the discharge header flow control valve.

2. Load Follow

A power reduction will initially cause a xenon buildup followed by xenon decay to a new, lower equilibrium value. The reverse occurs if the power level increases; initially, the xenon level decreases, and then it increases to a new and higher equilibrium value associated with the amount of the power level change.

The BTRS is normally used to vary the reactor coolant boron concentration to compensate for xenon transients occurring when reactor power level is changed. The RMCS may also be used to vary the boron concentration in the reactor coolant.

The most important intelligence available to the plant operator, enabling him to determine whether dilution or boration or the RCS is necessary, is the position of the control rods. For example, if the control rods are below their desired position, the operator must borate the reactor coolant to bring the rods outward. If, on the other hand, the control rods are above their desired position, the operator must dilute the reactor coolant to bring the rods inward.

During periods of plant loading, the reactor coolant expands as its temperature rises. The pressurizer absorbs this expansion as the level controller raises the level setpoint to the increased level associated with the new power level. The excess coolant due to RCS expansion is let down and stored in the VCT. During this period, the flow through the letdown orifice remains constant, and the charging flow is reduced by the pressurizer level control signal, resulting in an increased temperature at the regenerative HX outlet. The temperature controller downstream from the letdown HX increases the CCW flow to maintain the desired letdown temperature.

During periods of plant unloading, the charging flow is increased to make up for the coolant contraction not accommodated by the programmed reduction in pressurizer level.

3. Hot Standby

If required for periods of maintenance or following spurious reactor trips, the reactor can be held subcritical, but with the capability to return to full power within the period of time it takes to withdraw control rods. During this hot standby period, temperature is maintained at no-load Tavg by initially dumping steam to remove core residual heat, or at later stages by running RCPs to maintain system temperature.

Following shutdown, xenon buildup occurs and increases the degree of shutdown; i.e.; immediately after reactor trip, with initial xenon concentration and all control rods inserted, the core is maintained at a minimum of 1 percent $\Delta k/k$ subcritical. The effect of xenon buildup is to increase this value to a maximum of about 3 percent $\Delta k/k$ at about 8 hours following shutdown from equilibrium full-power conditions. If hot shutdown is maintained past this point, xenon decay results in a decrease in degree of shutdown. Since the value of the initial zenon concentration is about 3 percent $\Delta k/k$ (assuming that an equilibrium concentration had been reached during operation), boration of the reactor coolant is necessary to counteract the xenon decay and maintain shutdown.

If a rapid recovery is required, dilution of the system may be performed to counteract this xenon buildup. However, after the xenon concentration reaches a peak, boration must be performed to maintain the reactor subcritical as the xenon decays out.

4. Cold Shutdown

Cold shutdown is the operation that takes the reactor from hot shutdown conditions to cold shutdown conditions (reactor is subcritical by at least 1 percent Δk/k, and Tavg (200°F).

Before initiating venting of the RCS, the RCS hydrogen concentration is lowered by reducing the VCT overpressure, by replacing the VCT hydrogen atmosphere with nitrogen, and by continuous purging to the GWPS.

Before cooldown and depressurization of the reactor plant are initiated, the reactor coolant boron concentration is increased to the cold shutdown value. After the boration is completed and reactor coolant samples verify that the concentration is correct, the operator resets the RMCS for leakage makeup and system contraction at the shutdown reactor coolant boron concentration.

Contraction of the coolant during cooldown of the RCS results in actuation of the pressurizer level control to maintain normal pressurizer water level. The charging flow is increased, relative to letdown flow, and results in a decreasing VCT level. The VCT level controller automatically initiates makeup to maintain the inventory.

After the RHRS is placed in service and the RCPs are shut down, further cooling of the pressurizer liquid is accomplished by charging through the auxiliary spray line. Coincident with plant cooldown, a portion of the reactor coolant flow is diverted from the RHRS to the CVCS for cleanup. Demineralization of ionic radioactive impurities and stripping of fission gases from the VCT reduce the reactor coolant activity level sufficiently to permit personnel access for refueling or maintenance operations.

Should the normal systems be unavailable, safety-related backups are provided to achieve cold shutdown following an SSE and a LOOP. Appendix 5.4.A provides a systems-integrated discussion of cold shutdown under these conditions.

9.3.4.1.3 Safety Evaluation: The classification of structures, components, and systems is presented in Section 3.2. A further discussion on seismic design categories is given in Section 3.7. Conformance with Nuclear Regulatory Commission (NRC) general design criteria for plant systems, components, and structures important to safety is presented in Section 3.1.

9.3.4.1.3.1 Reactivity Control - Any time the plant is at power, the quantity of boric acid retained and ready for injection always exceeds that quantity required for the normal cold shutdown, assuming that the control assembly of greatest worth is in its fully withdrawn position. This quantity always exceeds the quantity of boric acid required to bring the reactor to hot shutdown and to compensate for subsequent xenon decay. An adequate quantity of boric acid is also available in the RWST to achieve cold shutdown.

When the reactor is subcritical (i.e., during cold or hot shutdown, refueling and approach to criticality) the neutron source multiplication is continuously monitored and indicated. Any appreciable increase in the neutron source multiplication, including that caused by the maximum physical boron dilution rate, is slow enough to give ample time to start a corrective action to prevent the core from becoming critical (the boron dilution accident is discussed in Section 15.2). The rate of boration, with a single boric acid transfer pump operating, is sufficient to take the reactor from full-power operation to 1 percent shutdown in the hot condition, with no rods inserted, in less than 90 minutes. In less than 90 additional minutes, enough boric acid can be injected to compensate for xenon decay, although xenon decay below the equilibrium operating level will not begin until approximately 25 hours after shutdown. Additional boric acid is employed if it is desired to bring the reactor to cold shutdown conditions.

Two separate and independent flow paths are available for reactor coolant boration; i.e., the charging line and the RCP seal injection line. A single failure does not result in the inability to borate the RCS.

If the normal charging line is not available, charging to the RCS is continued via RCP seal injection at the rate of approximately 5 gal/min per pump. At the charging rate of 20 gal/min (5 gal/min per RCP), a sufficient amount of boron is added to counteract the effects of xenon decay after reactor shutdown.

As backup to the normal boric acid supply, the operator can align the RWST outlet to the suction of the charging pumps.

Since inoperability of a single component does not impair ability to meet boron injection requirements, plant operating procedures allow components to be temporarily out of service for repairs. However, with an inoperable component, the ability to tolerate additional component failure is limited. Actions to be taken in the event of an inoperable boration flowpath are described in the Technical Requirements Manual.

9.3.4.1.3.2 Reactor Coolant Purification - The CVCS is capable of reducing the concentration of ionic isotopes in the purification stream as required in the design basis. This is accomplished by passing the letdown flow through one of the mixed-bed demineralizers, which removes ionic isotopes, except those of cesium, molybdenum, and yttrium, with a minimum decontamination factor of 10. Through occasional use of one of the cation-bed demineralizers, the concentration of cesium can be maintained below 1.0 μCi/cc, assuming 1 percent of the rated core thermal power is being produced by fuel with defective cladding. Each cation-bed demineralizer is capable of processing the maximum purification letdown flow rate. If the normally operating mixed-bed demineralizer's resin has become exhausted, the second demineralizer can be place in service. Each demineralizer is designed, however, to operate for one core cycle with 1 percent defective fuel.

A further cleanup feature is provided for use during RHR operations. A remote-operated valve admits a bypass flow from the RHRS into the letdown line at a point upstream of the letdown HX. A reactor coolant purification pump, located upstream of the letdown HX and capable of 450 gal/min flow, is provided for use when the inlet pressure from the RHRS is below 400 psig. The flow passes through the HX and then passes through the two mixed-bed demineralizers, the two cation-bed demineralizers, and the two reactor coolant filters (each set of components is operated in parallel to accommodate the high purification flow rate). The fluid is then returned to the RCS via the normal charging route or the RHRS.

The maximum temperature allowed for the mixed-bed and cation-bed demineralizers is approximately 140°F. If the temperature of the letdown stream approaches this level, the flow will be automatically diverted to bypass the demineralizers. If the letdown is not diverted, the only consequence would be a decrease in ion removal capability. Ion removal capability starts to decrease when the temperature of the resin goes above approximately 160°F for anion resin or above approximately 250°F for cation resin. The resins do not lose their exchange capability immediately. Ion exchange still takes place (at a faster rate) when temperature is increased. However, with increasing temperature, the resin loses some of its ion exchange sites, along with the ions that are held at the lost sites. The ions lost from the sites may be re-exchanged farther down the bed. The number of sites lost is a function of the temperature reached in the bed and of the time the bed remains at the high temperature. Capability for ion exchange will not be lost until a significant portion of the exchange sites are lost from the resin.

There would be no safety problem associated with overheating of the demineralizer resins. The only effect on reactor operating conditions would be the possibility of an increase in the reactor coolant activity level. If the activity level in the reactor coolant were to exceed the limit given in the Technical Specifications, reactor operation would be restricted as required by the Technical Specifications.

9.3.4.1.3.3. Seal Water Injection- Flow to the RCP seals is assured since there are three charging pumps. Either one of the centrifugal charging pumps is capable of supplying the normal charging line flow plus the nominal seal water flow. The positive displacement pump is designed to provide sufficient flow to meet the requirements for RCP seal injection.

9.3.4.1.3.4 Hydrostatic Testing of the Reactor Coolant System - The positive displacement pump can pressurize the RCS to its maximum specified hydrostatic test pressure. The pump is capable of producing a hydrostatic test pressure greater than that required.

9.3.4.1.3.5 Leakage Provisions - CVCS components, valves, and piping which see radioactive service are designed to limit leakage to the atmosphere. The following are preventive means provided to limit radioactive leakage to the environment.

1. The packed valves which are larger than 2 in. and which are designated for radioactive service are provided with stuffing box and lantern leakoff connections.

2. The control (modulating) and three-way valves either are provided with stuffing box and leakoff connections or are totally enclosed.

3. The piping joints and connections are welded except where flanged connections are provided to facilitate maintenance and hydrostatic testing.

The VCT provides an inferential measurement of leakage from the CVCS as well as from the RCS. The amount of leakage can be inferred from the amount of makeup added by the RMCS. During normal operation, the hydrogen and fission gases in the VCT are continuously purged to the GWPS, to limit the release of radioactive gases through leakage by maintaining the radioactive gas level in the reactor coolant several times lower than the equilibrium level. The mixed-bed demineralizers maintain reactor coolant purity, thus also reducing the radioactivity level of the RCS water.

Automatic isolation valves are provided for the CVCS lines that penetrate the Containment. The use of containment isolation valves in the letdown and seal water return lines precludes the transport of reactor coolant outside Containment during or following a transient or accident which has the potential to result in core damage. The CVCS is provided with redundant Class 1E room temperature elements which detect high energy letdown line breaks in the MAB and provide an isolation signal at the letdown line Containment penetration. These elements are provided to limit the magnitude and duration of the harsh temperature environment resulting from potential letdown line breaks.

9.3.4.1.3.6 Heat Tracing - Heat tracing requirements for boric acid solutions depend mainly upon the solution concentration. For STPEGS, the concentration of boric acid ranges from 10 ppm to 4-weight-percent boric acid. Heat tracing is provided on the tanks and piping handling 4 percent (by weight) boric acid, and is capable of maintaining the temperature in the boric acid tanks and piping of at least 65°F or higher), whenever needed.

9.3.4.1.3.7 Failure Mode and Effects Analysis - The CVCS provides a number of functions. Certain of these functions - such as automatic pressurizer level control, automatic makeup, purification, chemistry control, control of boron concentration for load follow, and RCP seal water injection - are supplied for normal plant operation purposes. These functions are not designed to the single-failure criterion, and failure of these functions, if not corrected, could result in operational restrictions or the reaching of operational limits requiring a plant shutdown.

The CVCS also provides safe shutdown functions of boration and makeup. The FMEA presented herein demonstrates that the single-failure criterion is met for these functions. In addition, the CVCS provides Containment isolation functions, which are covered in Chapter 6.

Borated water can be supplied to the charging pump suction header via either of two sources. They are:

1. The primary source is the BATs, which contain 4-weight-percent boric acid. Two tanks are provided in parallel, each with its own boric acid transfer pump. The discharge from these pumps is headered and normally is delivered to the charging pump suction header via the two series valves, FCV-110A and FCV-110B. Should this flow path be blocked for any reason, the operator will be alerted by the boric acid makeup flow deviation alarm.

   An emergency boration flow path from the discharge of the boric acid transfer pumps to the charging pump suction header is available by opening MOV XCV0218. This subsystem itself is seen to incorporate considerable redundancy of active components. In addition, a separate path via gravity drain from the BATs directly to the charging pump suction header is available by opening manual valves CV0333, CV0226, CV0335A and CV0335B.

2. A totally independent source of borated water is the RWST, containing 2,800-3,000 ppm boron. This supply is available upon opening either MOVs XCV0112C or XCV0113B, which directly supply refueling water to the charging pump suction header. This source therefore incorporates redundancy of active components.

Two charging pumps are provided in parallel to deliver borated water to the RCS via the charging line and/or the seal water injection line. Failure of the operating charging pump is detectable in the control room by:

- Charging pump discharge header pressure
- Charging flow rate, high and low flow alarms
- Seal water injection flow rates and low flow rate alarm
- Pressurizer level and low level alarm

The operator can start an alternate charging pump to reestablish flow. Blockage of either the charging line or the seal water injection line is detectable by the respective low flow alarms. This would reduce the rate of boration, but the alternate path remains available and provides an adequate flow rate.

In the event of a boric acid makeup fault during automatic makeup, there is potential to charge with unborated water. The boric acid makeup control provides boric acid flow indication and flow deviation alarms to alert the operator, and provides automatic isolation of valves FCV-110B and FCV111B to terminate reactor water makeup. Additional indication of boron dilution results from the control rod position indication and low and low-low insertion limit alarms, which would provide the operator adequate time to determine the cause of dilution and isolate the reactor water makeup source before shutdown margin is lost. The boron dilution accident is analyzed in Chapter 15. Table 9.3-12 summarizes results of a FMEA on this system for normal operation, demonstrating that single failures occurring during CVCS operation do not compromise the ability to prevent or mitigate accidents. These capabilities are accomplished by a combination of suitable redundancy, instrumentation for indication and/or alarm of abnormal conditions, and relief valves to protect piping and components against malfunctions.

Table 5.4.A-2 provides a FMEA for the safety-related portions of the CVCS that provide the safe shutdown functions of boration and makeup.

9.3.4.1.4 Tests and Inspections: As part of plant operation, periodic tests surveillance inspections, and instrument calibrations are made to monitor equipment condition and performance. Most components are in use regularly; therefore, assurance of the availability and performance of the systems and equipment is provided by control room and/or local indication.

Technical Specifications have been established concerning calibration, checking, and sampling of the CVCS.

Refer to Chapter 14 for further information.

9.3.4.1.5 Instrumentation Application: Process control instrumentation is provided to acquire data concerning key parameters about the CVCS. The location of the instrumentation is shown on Figures 9.3.4-1 through 9.3.4-5.

The instrumentation furnishes input signals for monitoring and/or alarming purposes. Indications and/or alarms are provided for the following parameters:

- Temperature
- Pressure
- Flow
- Water Level
- High suspended solids (turbidity)

The instrumentation also supplies input signals for control purposes. Some specific control functions are:

1. Letdown flow is diverted to the VCT upon high-temperature indication upstream of the mixed-bed demineralizers
2. Pressure upstream of the letdown HX is controlled to prevent flashing of the letdown liquid
3. Charging flow rate is controlled during charging pump operation
4. Water level is controlled in the VCT
5. Temperature of the boric acid solution in the batching tank is maintained
6. Reactor makeup is controlled
7. Temperature of letdown flow to the BTRS is controlled
8. Temperature of the chilled water flow to the letdown chiller HX is controlled
9. Temperature of letdown flow return from the boron thermal regeneration demineralizers is controlled

9.3.4.2 Boron Recycle System. The BRS recycles reactor coolant for reuse of boric acid and makeup water. The system decontaminates the effluent by means of demineralization and gas stripping and uses evaporation to separate and recover the boric acid and makeup water.

9.3.4.2.1 Design Bases:

9.3.4.2.1.1 Collection Requirements - The BRS collects and processes effluent which can be readily reused as makeup to the RCS. For the most part, this effluent is the deaerated, tritiated , borated, and radioactive water from the letdown.

Th BRS is designed to collect, via the letdown line in the CVCS, the excess reactor coolant that results from the following plant operations during one core cycle:

1. Dilution for core burnup from approximately 550 boron at the beginning of a semiannual core cycle to approximately 10 ppm near the end of the core cycle.

2. Hot shutdowns and startups. Two short hot standby operations with startup and two long hot standby operations with startup are assumed to take place each year.

3. Cold shutdowns and startups. Three cold shutdowns and startups are assumed to take place each year.

4. Refueling shutdown and startup.

The BRS can also collect and process water from the following sources:

1. Reactor coolant drain tank (LWPS) - Collects leakoff-type drains from equipment inside the Containment (normally processed by LWPS).

2. VCT pressure reliefs (CVCS).

3. Boric Acid Blend System (CVCS) - Provides storage of boric acid if a BAT must be emptied for maintenance. The boric acid solution is stored in a recycle holdup tank (RHT) after first being diluted with reactor makeup water by the blend system to ensure against precipitation of the boric acid in the unheated RHT.

4. Accumulators (SIS) - Collect effluent resulting from leak testing of accumulator check valves.

5. Spent fuel pool (SFP) pumps (SFPCCS) - Provide a means of storing the fuel transfer canal water in case maintenance is required on the transfer equipment.

6. BTRS demineralizers.

7. Waste evaporator condensate tank (LWPS).

9.3.4.2.1.2 Capacity Requirements - The BRS is designed to process the total volume of water collected during a core cycle as well as short-term surges. The design surge is that produced by a cold shutdown and subsequent startup during the latter part of a core cycle or by refueling shutdown and startup.

9.3.4.2.1.3 Purification Requirements - The water collected by the BRS contains dissolved gases, boric acid, and suspended solids. Based upon reactor operations with 1 percent fuel defects, the BRS is designed to provide sufficient cleanup of the water to satisfy the chemistry requirements of the recycled reactor makeup water and 4-weight-percent boric acid solution.

The maximum radioactivity concentration buildup in the BRS components is based upon operation of the reactor with 1 percent fuel defects. For each component, the shielding design considers the maximum buildup on an isotopic basis. Filtration, demineralization, and evaporation are the means by which the activity concentrations are controlled.

9.3.4.2.2 System Description: The BRS is shown on Figures 9.3.4-6 and 9.3.4-7. The codes and standards, quality classification, and seismic criteria required for the design of individual components of the BRS are listed in Section 3.2. During normal operation, the letdown from the CVCS is directed to the BRS. The letdown is processed by the recycle evaporator feed demineralizers and filters before it is collected in RHTs. The recycle evaporator feed pumps can be used to transfer liquid from one RHT to the other if desired. When sufficient liquid is accumulated to warrant evaporator operation, the recycle evaporator feed pumps take suction from the selected RHT. The fluid then flows through the recycle evaporator. Here, dissolved gases (i.e., hydrogen, fission gases, and other gases) are removed in the stripping column before the liquid enters the evaporator shell. These gases are directed to the GWPS.

During evaporator operation, distillate from the evaporator is normally processed by the recycle evaporator condensate demineralizer and the recycle evaporator condensate filter and is transferred to the RMWST. A radiation monitor continuously monitors the evaporator distillate; upon detection of high activity, a three-way diversion valve is tripped to return the distillate to the feed demineralizers and the RHTs.

The evaporator concentrates the boric acid solution until a 4-weight-percent solution is obtained. The accumulated batch is normally transferred directly to the BATs in the CVCS through the recycle evaporator concentrates filter, or after polishing through the boric acid polishing demineralizer and filter. Before transferring the boric acid from the evaporator to the BATs, it is analyzed, and if it does not meet the required chemical standards, it can be diverted back to the feed demineralizers and recycle holdup tanks for reprocessing or to the LWPS for disposal.

Connections are provided so that, if necessary, the waste evaporator can be used for processing the contents of the RHT, if the recycle evaporator is not available due to maintenance, etc. However, the recycle evaporator is not designed to serve as a backup for the waste evaporator.

The portions of the BRS which contain concentrated boric acid solution are heat traced in order to maintain solution temperature at greater than or equal to 65°F. This is 10°F above the solubility limit for the nominal 4-weight-percent boric acid solution.

9.3.4.2.2.1 Component Descriptions - A summary of principal component data is given in Table 9.3-11 and the code requirements are given in Section 3.2.

Recycle Evaporator Feed Pumps

Two centrifugal, canned pumps supply feed to the recycle evaporator package from the RHTs. The pumps can also be used to recirculate water from the RHTs through the recycle evaporator feed demineralizers for cleanup if desired. An auxiliary discharge connection is provided to return water to the transfer canal from the RHTs, if those tanks were used for storage of transfer canal water during refueling equipment maintenance. Another auxiliary discharge connection is provided to supply water to the suction of the charging pumps (CVCS) for refilling the RCS after loop or system drain.

Recycle Holdup Tanks

Two RHTs provide storage for radioactive fluid which is discharged from the RCS during startup, shutdown, load changes, and boron dilution and is to be processed by the evaporator package. Each tank has a diaphragm which prevents air from dissolving in the water and prevents the hydrogen and fission gases in the water from mixing with air.

Recycle Evaporator Reagent Tank

This tank provides a means of adding chemicals to the evaporator, e.g., for cleanup.

Recycle Evaporator Feed Demineralizers

Two flushable mixed-bed demineralizers remove fission products from the fluid directed to the RHTs. The demineralizers also provide a means of cleaning the RHT contents via recirculation.

Recycle Evaporator Condensate Demineralizer

A mixed-bed demineralizer is provided as a polishing demineralizer for distillate from the recycle evaporator. The demineralizer also provides a means of cleanup of the RMWST contents. This demineralizer removes cations, such as calcium and magnesium, as well as boron.

Recycle Evaporator Feed Filters

These two filters collect resin fines and particulates from the fluid entering the RHTs.

Recycle Evaporator Condensate Filter

This filter collects resin fines and particulates from the boric acid evaporator condensate stream.

Recycle Evaporator Concentrates Filter

This filter removes particulates from the evaporator concentrate as it leaves the evaporator.

Sample Preconditioning Demineralizer

This demineralizer is used for preconditioning the recycle evaporator distillate sample prior to analysis for conductivity so that the quality of liquid transferred from the recycle evaporator to the RMWST can be controlled. The demineralizer consists of strong base type disposable anionic resin cartridge.

Recycle Evaporator

The recycle evaporator package processes dilute boric acid and produces distillate and approximately 4-weight-percent boric acid stripped of hydrogen, radioactive gases, and other dissolved gases.

A boric acid solution is fed from the RHTs to the evaporator by the recycle evaporator feed pumps. The feed first passes through an HX, where condensing steam raises its temperature, and then into the top of the stripping column. Gases are stripped off as the feed passes over the packing in the tower in contraflow to stripping steam from the evaporator. After stripping, the feed is introduced into the evaporator as makeup. The vapors leaving the boiling pool are stripped of entrained liquid and volatile boron carryover. Pure vapors are then condensed in the condenser section and pumped from the system. When the desired concentration is reached in the boiling pool, the concentrates are pumped from the system.

Radioactive gases, hydrogen, and other noncondensibles are discharged from the system into the waste gas vent header.

9.3.4.2.2.2 System Operation - The BRS is manually operated, with the exception of a few automatic protection functions. These automatic functions protect the recycle evaporator feed demineralizers from a high inlet temperature and a high differential pressure, prevent a high vacuum from being drawn on the RHT diaphragm, protect the recycle evaporator feed pumps from low NPSH, and prevent high-activity or high conductivity recycle evaporator condensate from being sent to the RMWST. The BRS has sufficient instrumentation readouts and alarms to provide the operator with information to assure proper system operation.

Evaporation

Water is accumulated in the RHT until sufficient quantity exists to warrant an evaporator startup. Prior to startup of the evaporator, the contents of the RHT are analyzed and, if necessary, are recirculated through the recycle evaporator feed demineralizers and filter. The flow can be discharged back to the RHT or to the evaporator. The evaporator is then operated to produce a batch of 4-weight-percent boric acid.

During the operation of the evaporator, condensate is normally sent to the RMWST via the recycle evaporator condensate demineralizer. The condensate is monitored for high activity, and, on a high-radiation alarm, the flow is automatically diverted to the RHT for reprocessing.

After a batch of boric acid is concentrated to 4-weight-percent, it is analyzed to ensure that it is within specifications for reuse. If it meets the specifications, it is pumped to the BATs either directly or after polishing by the concentrated boric acid polishing demineralizer and filter. If it does not, it can be returned to the RHT via the recycle evaporator feed demineralizers for reevaporation or, if desired, the concentrated boric acid can be sent to the LWPS for disposal.

Recycle Holdup Tank Venting

Because hydrogen is dissolved in the reactor coolant at approximately one atmosphere overpressure, a portion of the hydrogen, along with fission gases, will come out of solution in the RHT under the diaphragm. The hydrogen and fission gases are vented to the GWPS as required. The total integrated flow from the letdown line and the RCDT to the RHTs is monitored. An alarm indicates when a sufficient amount of water has passed to the RHTs to require venting of the accumulated gases. An RHT should also be vented before and after a RCS loop drain or a drain from the fuel storage area (or fuel transfer canal).

When venting of either RHT is required, the following steps are observed:

1. All inlets to the RHT are closed.

2. The RHT is emptied of water by either processing with the evaporator or transferring to the other RHT.

3. The GWPS bellows compressor is lined up to the RHT vent. The compressor will feed the gas from the inlet header to the GWPS.

4. The compressor is started up, and the vent valve from the RHT and the vent isolation valve are opened.

5. When the gases have been vented from the RHT, the pressure in the vent line decreases, which automatically closes the RHT vent isolation valve.

6. After the vent isolation valve closes, the manual vent valve is closed, the compressor is shut down, and the RHT inlets and outlets are lined up for normal use. The compressor is designed to alarm and shut down at low suction pressure, for its protection.

Maintenance Drains

When large amounts of water must be drained from the RCS to the BRS, an RHT is drained of water and vented to the GWPS. The water can be stored in this tank until maintenance is completed and then, after checking the chemistry, returned. After returning the water, the RHT is again vented to the GWPS.

Reactor Makeup Water Cleanup

If the reactor makeup water requires purification, it can be recirculated through the recycle evaporator condensate demineralizer until its chemistry is within specifications. If further processing is necessary, water from the RMWST can be directed through the recycle evaporator condensate demineralizer and into the RHTs for reevaporation.

Processing of Reactor Coolant Grade Leakages With The Recycle Evaporator

Connections are provided so that the recycle evaporator can be used for processing reactor coolant grade equipment leakages which are collected in the RCDT and transferred to the WHT for processing. These consist of a feed connection from the WHT, a condensate connection to the waste evaporator condensate tank (WECT), a concentrate connection to the concentrate storage tank, and an evaporator vent connection to the plant vent.

During processing of the WHT by the recycle evaporator, the condensate is directed to the WECT for analysis prior to recycling to the RMWST. Depending upon the purity of the evaporator bottoms, the concentrated boric acid can be recycled to the BATs, returned to the RHTs fo reprocessing, or transferred to the SWPS for disposal.

The recycle evaporator shall be thoroughly rinsed after processing the contents of the WHT is completed. Even though this provides a path for processing LWPS by using the boron recycle evaporator, it is not intended to serve as a backup to the LWPS evaporator due to (a) design (LWPS:

Forced Circulation; BRS, submerged tube), (b) material of construction (LWPS: Incoloy 825; BRS, stainless steel), and (c) heat tracing (BRS evaporator is designed to handle 4-weight-percent boric acid only).

RHT Processing by LWPS Evaporator

If the BRS recycle evaporator is not available (due to maintenance, etc.) the LWPS evaporator can be used for processing the contents of the RHT. Connections are provided to feed the LWPS evaporator from the RHT, to transfer the LWPS evaporator condensate to WECT, and to transfer the boric acid concentrate to the concentrate storage tank for solidification and disposal. When the RHT contents are processed by the LWPS evaporator, the boric acid will be concentrated to 12-weight-percent, solidfied and disposed of rather than recycled to the boric acid tank. The condensate from the LWPS evaporator can be recycled to the RMWST if it meets the recycle chemistry requirements (after sampling in WECT).

Sampling Water Enroute from Recycle Evaporator to RMWST

The distillate from the Recycle Evaporator can be sampled and analyzed for conductivity from three locations, namely from (a) distillate cooler, (b) unpolished distillate from the recycle evaporator, and (c) polished distillate from the recycle evaporator. The selection of the location of sample is by manual control. The sample is processed through the Sample Preconditioning Demineralizer (containing anionic resin) prior to analysis for conductivity.

9.3.4.2.3 Safety Evaluation: Malfunctions in the BRS do not affect the safety of station operations. The BRS is designed to tolerate equipment faults, with critical functions being met by the use of two pieces of equipment so that the failure of one will, at most, reduce the capacity of the BRS but not completely shut it down. Because of the large surge capacity of the BRS, the nonavailability of the recycle evaporator can be tolerated for periods of time. Also, backup is provided by the waste evaporator.

9.3.4.2.4 Tests and Inspections: The BRS is in intermittent use throughout normal reactor operation. Periodic visual inspection and preventive maintenance are conducted using normal industry practice. Refer to Chapter 14 for further information.

9.3.4.2.5 Instrumentation Application: The instrumentation available for the BRS is discussed below. Alarms are provided as noted. There is also a common alarm on the main control board which indicates any alarms on the BRS panel.

9.3.4.2.5.1 Temperature - Instrumentation is provided to measure the temperature of the inlet flow to the recycle evaporator feed demineralizers and to control a three-way bypass valve. If the inlet temperature becomes too high, the instrumentation aligns the valve to bypass the demineralizers. Local temperature indication and a high-temperature alarm on the BRS panel are provided by this instrumentation.

9.3.4.2.5.2 Pressure -

Pressure Differential Across the Recycle Evaporator Feed Demineralizers

Instrumentation is provided to measure the pressure differential across the recycle evaporator feed demineralizers and to control the same three-way valve as discussed above (but independently of the temperature control). If the pressure drop through the demineralizers is too high, this instrumentation aligns the valve to divert flow directly to the recycle evaporator feed filters. Local pressure differential indication and a high alarm on the BRS panel are provided by this instrumentation.

Pressure at Inlet and Outlet of Filters

Instrumentation is provided to measure the pressure differential across each recycle evaporator feed filter, the recycle evaporator concentrates filter, and the recycle evaporator condensate filter. Local indication of the pressure in each inlet and outlet line is provided.

Pressure at Discharge of Recycle Evaporator Feed Pump

Instrumentation is provided to measure and give local indication of the discharge pressure of each recycle evaporator feed pump.

Pressure in Vent Line from the Recycle Holdup Tanks

Instrumentation is provided to measure the pressure in the RHT vent line and to control a shutoff valve in the vent line. This instrumentation is used during holdup tank venting operations. When the pressure in this line becomes too low, the valve is automatically closed to protect the holdup tank diaphragm from an excessive differential pressure across it. Local pressure indication and low-pressure alarm on the BRS panel are provided.

9.3.4.2.5.3 Flow -

Boron Recycle System Flow Totalizer

Instrumentation is provided to monitor the total integrated flow received by the BRS from the letdown line (CVCS). Indication of integrated flow and high alarm are given on the BRS panel. Actuation of the high alarm indicates that the integrated flow has reached a value at which the volume of gases (hydrogen and fission gases) which have come out of solution should be vented from the RHTs.

Flow in Vent Line from Recycle Holdup Tanks

Instrumentation is provided which gives local indication of the RHT vent purge flow for each tank.

Flow in Feed Line to the Recycle Evaporator

Instrumentation is provided which gives local indication of recycle evaporator feed flow.

9.3.4.2.5.4 Level - Instrumentation is provided to give an indication of the water level of each RHT. Both high level and low level alarms are provided by this instrumentation at the BRS panel. If, after reaching the low level alarm setpoint, the recycle evaporator feed pumps are not stopped, the holdup tank level will continue to decrease until a second low-level point is reached and a level-actuated control circuit stops the pumps.

9.3.4.2.5.5 Radiation - Instrumentation is provided to give an indication in the radwaste control room of the radiation level in the recycle evaporator condensate. Upon a high-level signal, this system causes a three-way valve to divert flow back to the recycle evaporator feed demineralizers. This instrumentation also has a high radiation level alarm on the BRS panel. Radiation level information and high radiation alarm are also available in the main control room, through the Radiation Monitoring System.

9.3.4.2.5.6 Conductivity -

Conductivity Level of Recycle Evaporator Condensate

Instrumentation is provided to measure the conductivity level of recycle evaporator condensate; a high-conductivity alarm is provided on the reactor coolant purity control local panel. Upon a high-conductivity signal (independent of the high-radioactivity signal above), the three-way valve will divert flow back to the recycle evaporator feed demineralizers.

Conductivity Level of Sampled Recycle Evaporator Condensate

Instrumentation is provided to measure the conductivity level of sampled recycle evaporator condensate. Three points of sample are available; selection is by use of manual valves. Recording and high conductivity alarms are provided on the reactor coolant purity control panel.

9.3.5 Standby Liquid Control System

This section does not apply to STPEGS.

9.3.6 Failed Fuel Detection

See Section 11.5.2.4.8 for a description of the failed fuel monitor.

TABLE 9.3-2

FAILURE MODE AND EFFECTS ANALYSIS FOR AIR-OPERATED VALVES

System	Table
Main Steam System	10.3-1
Residual Heat Removal System	5.4A-2
Component Cooling Water System	9.2.2-3
Containment Isolation System	6.2.4-1
Essential Cooling Water System	9.2.1-2
Chemical & Volume Control System	9.3-12
Control Room & Electrical Aux. Building HVAC	9.4-5.1
Fuel Handling Building HVAC	9.4-5.2
Diesel Generator Building HVAC	9.4-5.6
Essential Chilled Water System	9.4-5.1
Essential Cooling Water Intake Structure HVAC	9.4-5.7
Emergency Core Cooling System	6.3-10
Auxiliary Feedwater System	10.4-3
Turbine Bypass System	10.4-4
Feedwater System	10.4-8
Steam Generator Blowdown System	10.4-9

TABLE 9.3-3

PROCESS SAMPLE DESCRIPTION

Location	Description	Purpose	Analyses[1]	Sample Inlet Conditions Pressure Design/Operating[2]	Sample Inlet Conditions Temperature Design/Operating[2]
Primary Sampling System					
A. Reactor Coolant System					
1. Hot Leg, Reactor Coolant	Liquid, grab sample (sample vessel)	Determine purification requirements, monitor fission and activated corrosion products, monitor chemistry	Various	2485/2235 psig	650/624°F
2. Pressurizer Vapor Space	Vapor, grab sample (sample vessel)	Monitor pressurizer chemistry and activity	Various	2485/2235 psig	680/653°F
3. Pressurizer Liquid	Liquid, grab sample (sample vessel)	Monitor pressurizer chemistry and activity	Various	2485/2235 psig	680/653°F
B. Chemical Volume and Control System					
1. Upstream Mixed-Bed Demineralizers	Liquid, grab sample (sample vessel)	Evaluate demineralizer performance	Various	300/150 psig	250/115°F
2. Downstream Cation-Bed Demineralizers	Liquid, grab sample (sample vessel)	Evaluate demineralizer performance	Various	300/150 psig	250/115°F
3. Downstream Thermal Regeneration Demineralizers	Liquid, grab sample (sample vessel)	Evaluate demineralizer performance	Various	300/150 psig	250/115°F
4. Volume Control Tank Liquid Sample	Liquid, grab sample (sample vessel)	Monitor chemistry	Various	85/60 psig	250/115°F
C. Residual Heat Removal System	Liquid, grab sample (sample vessel)	Monitor RCS	Various	600/400 psig	400/150°F

1. The analysis of grab samples will be in accordance with plant chemistry specifications.
2. The operating conditions listed are at T-avg = 593°F.

TABLE 9.3-3 (Continued)

PROCESS SAMPLE DESCRIPTION

Location	Description	Purpose	Analyses(1)	Sample Inlet Conditions Pressure Design/Operating(2)	Sample Inlet Conditions Temperature Design/Operating(2)
Primary Sampling System (Continued)					
D. Safety Injection System					
1. Safety Injection Accumulators	Liquid, grab sample (sample vessel)	General monitoring	Various	700/650 psig	300/150°F
2. HHSI Pumps Discharge	Liquid, grab sample (sample vessel)	General monitoring	Various	1750/1260 psig	300/265°F
E. Reactor Makeup Water Storage Tank	Liquid, grab sample	Monitor chemistry	Various	170/120 psig	120/80°F
F. Deleted					
G. Liquid Waste Processing System					
1. Waste Holdup Tank	Liquid, grab sample (sample vessel)	Monitor activity levels	Various	150/95 psig	200/85°F
2. Reactor Coolant Drain Tank Downstream Piping	Liquid, grab sample (sample vessel)	Monitor activity levels	Various	150/95 psig	200/130°F
3. Water Evaporator Condensate Tanks	Liquid, grab sample (sample vessel)	Monitor activity levels	Various	150/95 psig	200/120°F
4. Laundry and Hot Shower Tank	Liquid, grab sample (sample vessel)	Monitor activity levels	Various	150/95 psig	200/85°F
5. Floor Drain Tank	Liquid, grab sample (sample vessel)	Monitor activity levels	Various	150/95 psig	200/85°F
6. Condensate Polishing Regeneration on Waste Collection Tank	Liquid, grab sample (sample vessel)	Monitor activity levels	Various	150/95 psig	200/85°F

1. The analysis of grab samples will be in accordance with plant chemistry specifications.
2. The operating conditions listed are at T-avg = 593°F.

TABLE 9.3-3 (Continued)

PROCESS SAMPLE DESCRIPTION

Location	Description	Purpose	Analyses[1]	Sample Inlet Conditions Pressure Design/Operating[2]	Sample Inlet Conditions Temperature Design/Operating[2]
Primary Sampling System (Continued)					
7. Waste Monitor Tanks	Liquid, grab sample (sample vessel)	Monitor activity levels	Various	150/95 psig	200/85°F
8. Waste Evaporator Condensate Demineralizer Outlet	Liquid, grab sample (sample vessel)	Evaluate demineralizer performance	Various	150/95 psig	200/85°F
9. Waste Holdup Tank Purification Demineralizer Outlet	Liquid, grab sample (sample vessel)	Evaluate demineralizer performance	Various	150/95 psig	200/85°F
10. LWPS Evaporator Feed	Liquid, grab sample (sample vessel)	Evaluate demineralizer performance	Various	150/95 psig	200/85°F
11. LWPS Evaporator Distillate	Liquid, grab sample (sample vessel)	Evaluate demineralizer performance	Various	150/95 psig	200/120°F
12. LWPS Auxiliary Demineralizer Outlet	Liquid, grab sample (sample vessel)	Evaluate demineralizer performance	Various	150/95 psig	200/85°F
H. Spent Fuel Pool Cooling and Cleanup System					
1. Spent Fuel Pool Demineralizers Inlet	Liquid, grab sample (sample vessel)	Monitor chemistry	Various	300/150 psig	250/120°F
2. Spent Fuel Pool Demineralizers Outlet	Liquid, grab sample (sample vessel)	Monitor chemistry	Various	300/125 psig	250/120°F
I. Boron Recycle System					
1. BRS Evaporator Feed Demineralizers Inlet	Liquid, grab sample (sample vessel)	Monitor chemistry	Various	300/150 psig	250/150°F
2. BRS Evaporator Feed Demineralizers Outlet	Liquid, grab sample (sample vessel)	Monitor chemistry	Various	300/150 psig	250/150°F

1. The analysis of grab samples will be in accordance with plant chemistry specifications.
2. The operating conditions listed are at T-avg = 593°F.

TABLE 9.3-3 (Continued)

PROCESS SAMPLE DESCRIPTION

Location	Description	Purpose	Analyses[1]	Sample Inlet Conditions Pressure Design/Operating[2]	Sample Inlet Conditions Temperature Design/Operating[2]
Primary Sampling System (Continued)					
3. BRS Evaporator Condensate Demineralizer	Liquid, grab sample (sample vessel)	Monitor chemistry	Various	150/90 psig	250/130°F
4. Recycle Evaporator Feed Pump Discharge	Liquid, grab sample (sample vessel)	Monitor chemistry	Various	150/110 psig	250/85°F
J. Steam Generator Bulk Water	Liquid, grab sample (sample vessel)	Monitor bulk water chemistry	Various	1300/1100 psia	660/556°F
Secondary Sampling System					
A. Steam Generator Blowdown System					
1. Each SG	Continuous in-line	Monitor SG chemistry	pH, conductivity, silica, sodium, cation conductivity, chloride	1300/1100 psia	600/556°F
	Liquid, grab sample	Monitor SG chemistry check on in-line monitor	Various	1300/1100 psia	600/556°F
	Liquid, intermittent	Monitor SG chemistry	Corrosion products	1300/1100 psia	600/556°F
2. SGDB Mixed Bed Demineralizers Outlet	Continuous in-line	Monitor chemistry	Specific conductivity, cation conductivity	265/150 psig	200/140°F

1. The analysis of grab samples will be in accordance with plant chemistry specifications.
2. The operating conditions listed are at T-avg = 593°F.

TABLE 9.3-3 (Continued)

PROCESS SAMPLE DESCRIPTION

Location	Description	Purpose	Analyses[1]	Sample Inlet Conditions Pressure Design/Operating[2]	Sample Inlet Conditions Temperature Design/Operating[2]
Secondary Sampling System (Continued)					
B. Main Steam System	Continuous in-line	Monitor chemistry and carryover	pH, silica, cation conductivity	1285/1100 psig	600/556°F
	Liquid, grab sample	Monitor chemistry and carryover	Various	1285/1100 psig	600/556°F
C. Condensate System					
1. Condensate Pumps Discharge	Continuous in-line	Monitor chemistry	Sodium, cation conductivity, O_2, conductivity, pH, hydrazine	800/570 psig	390/120°F
	Liquid, grab sample	Monitor chemistry	Various	800/570 psig	390/120°F
	Liquid, intermittent	Monitor chemistry	Corrosion products	800/570 psia	390/120°F
2. LP FW Heaters Inlet Header	Continuous in-line	Monitor amine feed and hydrazine feed	pH, hydrazine, specific [illegible]	800/550 psig	390/122°F
	Liquid, grab sample	Monitor amine feed and hydrazine feed	Various	800/500 psig	390/122°F
3. Condenser Hotwells	Continuous in-line	Monitor leakage	Cation conductivity, conductivity sodium, O_2	50 psig/ 1.7 psia	160/120°F
	Liquid, grab sample	Monitor leakage	Various	50 psig/ 1.7 psia	160/120°F

1. The analysis of grab samples will be in accordance with plant chemistry specifications.
2. The operating conditions listed are at T-avg = 593°F.

TABLE 9.3-3 (Continued)

PROCESS SAMPLE DESCRIPTION

Location	Description	Purpose	Analyses[1]	Sample Inlet Conditions Pressure Design/Operating[2]	Sample Inlet Conditions Temperature Design/Operating[2]
Secondary Sampling System (Continued)					
D. Feedwater System					
1. FW Header to SGs	Continuous in-line	Monitor chemistry in FW	pH, O_2, hydrazine, conductivity, cation conductivity,	1930/1210 psig	465/440°F
	Liquid, grab sample	Monitor chemistry in FW	Various	1930/1210 psig	465/440°F
	Liquid, intermittent	Monitor chemistry	Corrosion products	1930/1210 psig	465/440°F
2. Deaerator Inlet	Continuous in-line	Monitor chemistry	O_2	800/175 psig	390/315°F
	Liquid, intermittent	Monitor chemistry	Corrosion products	800/175 psig	390/315°F
3. Deaerator Blowdown	Liquid, intermittent	Monitor chemistry	Corrosion products	250/200 psig	400/380°F
E. Auxiliary Cooling Water System	Continuous in-line	Monitor leakage	Specific conductivity, pH, O_2	150/130 psig	125/105F
	Liquid, grab sample	Monitor leakage	Various	150/130 psig	125/105°F

1. The analysis of grab samples will be in accordance with plant chemistry specifications.
2. The operating conditions listed are at T-avg = 593°F.

TABLE 9.3-3 (Continued)

PROCESS SAMPLE DESCRIPTION

Location	Description	Purpose	Analyses(1)	Sample Inlet Conditions Pressure Design/Operating(2)	Sample Inlet Conditions Temperature Design/Operating(2)
Secondary Sampling System (Continued)					
F. Heater Drips System					
1. LP FW Heater Drip Pumps	Continuous in-line	Monitor chemistry	O_2,	800/513 psig	230/174°F
	Liquid, grab sample	Monitor chemistry	Various	800/513 psig	230/174°F
	Liquid, intermittent	Monitor chemistry	Corrosion products	800/513 psig	230/174°F
2. HP Heater Drips	Liquid, intermittent	Monitor chemistry	Corrosion products	460/400 psig	470/450°F
3. MSR Drains	Liquid, intermittent	Monitor chemistry	Corrosion products	460/179 psig	470/380°F
G. Circulating Water System					
1. Circulating Water Condenser Water Boxes	Continuous in-line	Monitor chemistry	Residual chlorine	55/20 psig	115/100°F
	Liquid, grab sample	Monitor chemistry	Various	55/20 psig	115/100°F
H. Condensate Storage System					
1. Secondary Makeup Storage	Liquid, grab sample	Determine water quality in tank	Various	75/30 psig	160/90°F
	Continuous in-line	Monitor chemistry	Cation conductivity, O_2	75/30 psig	160/90°F
2. AFW Storage Tank	In-line	Monitor chemistry	Hydrazine, O_2	50/19 psig	120/90°F

1. The analysis of grab samples will be in accordance with plant chemistry specifications.
2. The operating conditions listed are at T-avg = 593°F

TABLE 9.3-3 (Continued)

PROCESS SAMPLE DESCRIPTION

Location	Description	Purpose	Analyses[1]	Sample Inlet Conditions Pressure Design/Operating[2]	Sample Inlet Conditions Temperature Design/Operating[2]
Secondary Sampling System (Continued)					
I. Condensate Polisher System					
1. Polishing Demineralizer Discharge	Continuous in-line	Monitor chemistry	Sodium, silica, cation conductivity, specific conductivity, pH, O_2	800/615 psig	390/120°F
	Liquid, grab sample	Monitor chemistry	Various	800/615 psig	390/120°F
	Liquid, intermittent	Monitor chemistry	Corrosion products	800/615 psig	390/120°F
2. Cation Bed Discharge	Liquid, intermittent	Monitor chemistry	Corrosion products	800/600 psig	135/120°F

1. The analysis of grab samples will be in accordance with plant chemistry specifications.
2. The operating conditions listed are at T-avg = 593°F

TABLE 9.3-3A

POST-ACCIDENT SAMPLE DESCRIPTION[1]

Location	Description	Purpose	Analyses[2]	Activity[3]	Sample Inlet Conditions: Pressure PSIG	Sample Inlet Conditions: Temperature Design/Operating[4]
Reactor Coolant System	Liquid, on-line	Verification analysis	pH	10 Ci/gm	2485/2235 psig	650/626°F
	Liquid, grab sample (sample vessel)	Verification analysis	Various			
Residual Heat Removal System	Liquid, on-line	Verification analysis	pH	0.4 Ci/gm	600/464 psig	400/345°F
	Liquid, grab sample (sample vessel)	Verification analysis	Various			
Containment Normal Sump	Liquid, on-line	Verification analysis	pH	0.4 Ci/gm	Atm/0.3 psig	150/150°F
	Liquid, grab sample (sample vessel)	Verification analysis	Various			

1. Containment atmosphere hydrogen is monitored by the Hydrogen Monitoring System discussed in Section 7.6.5.
2. The analysis of grab samples will be in accordance with plant chemistry specifications.
3. Accident conditions.
4. The operating conditions listed are at T_{avg} = 593°F.

TABLE 9.3-3A (Continued)

POST-ACCIDENT SAMPLE DESCRIPTION[1]

Location	Description	Purpose	Analyses[2]	Activity[3]	Sample Inlet Conditions Pressure PSIG	Sample Inlet Conditions Temperature Design/Operating[4]
Containment Atmosphere	Gas, grab sample (sample vessel)	Verification analysis	Various		56.5/0.3 psig	330/110°F

1. Containment atmosphere hydrogen is monitored by the Hydrogen Monitoring System discussed in Section 7.6.5.
2. The analysis of grab samples will be in accordance with plant chemistry specifications.
3. Accident conditions.
4. The operating conditions listed are at T_{avg} = 593°F.

TABLE 9.3-4

LOCAL GRAB SAMPLES[1]

Location	Description	Purpose	UFSAR Figure Reference
Radiological Monitoring			
A. Liquid Waste Processing System			
1. Spent resin sluice pump discharge	Liquid	Determine activity levels in sluice stream	11.2-3
2. Waste evaporator concentrates	Liquid	Evaluate evaporator performance	11.2-6
3. Reactor coolant drain tank	Gas	Monitor activity in tank	11.2-1
B. Gaseous Waste Processing System			
1. Charcoal bed tank outlet	Gas	Monitor releases	11.3-2
2. Charcoal bed tank inlet	Gas	Monitor activity	11.3-2
3. Guard bed tank inlet	Gas	Monitor activity	11.3-2
C. Reactor Coolant Vacuum Degassing System			
1. Gas storage tanks	Gas	Monitor activity	11.3-3
D. Safety Injection System			
1. Refueling water storage tank	Liquid	Determine activity	6.3-1
E. Chemical and Volume Control System			
1. Volume control tank	Gas	Determine activity level in tank	9.3.4-3
F. Reactor Coolant System			
1. Pressurizer relief tank	Gas	Determine activity level in tank	5.1-4

1. The analysis and frequency of grab samples will be in accordance with plant chemistry specification.

TABLE 9.3-4 (Continued)

LOCAL GRAB SAMPLES[1]

Location	Description	Purpose	UFSAR Figure Reference
Chemical Monitoring			
A. Well Water Supply System			
1. Well water pumps	Liquid sample from each pump discharge	Monitor water quality	None
B. Fresh Water Supply System			
1. Well water sodium hypoclorite pump discharge	Liquid	Monitor chemistry	None
2. Settling basin inlet	Liquid	Monitor chemistry	None
3. Fresh water pumps discharge	Liquid	Monitor chemistry	None
4. Fresh water pressure filters inlet	Liquid	Determine filter performance	None
5. Fresh water pressure filters outlet	Liquid	Determine filter performance	None
C. Acid and Caustic System			
1. Acid storage tanks	Liquid	Monitor chemistry	None
2. Caustic storage tank	Liquid	Monitor chemistry	None
D. Fuel Oil Storage and Transfer System			
1. Auxiliary fuel oil storage tank	Liquid	Monitor chemistry	9.5.10-1
2. Fire pump diesel driver fuel oil storage tanks	Liquid	Monitor chemistry	9.5.10-1

1. The analysis and frequency of grab samples will be in accordance with plant chemistry specification.

TABLE 9.3-4 (Continued)

LOCAL GRAB SAMPLES[1]

Location	Description	Purpose	UFSAR Figure Reference
Chemical Monitoring (Continued)			
E.. Potable Water System			
DELETED			
F. Condensate Storage System			
1. Secondary make-up tank	Liquid	Determine water quality in tank	9.2.6-2
G. Sodium Hypochlorite Generation and Injection System			
DELETED			
H. Condenser Air Removal System			
1. Discharge to atmosphere	Gas	Monitor air quality	10.4.2-1

1. The analysis and frequency of grab samples will be in accordance with plant chemistry specification

TABLE 9.3-4 (Continued)

LOCAL GRAB SAMPLES[1]

Location	Description	Purpose	UFSAR Figure Reference
Chemical Monitoring (Continued)			
I. Chemical Feed System			
1. Hydrazine supply tanks	Liquid	Determine quality of hydrazine	None
2. Condensate pH control reagent feed pumps suction	Liquid	Determine quality of pH control reagent	None
3. Secondary pH control reagent storage tanks	Liquid	Determine quality of pH control reagent	None
4. Auxiliary boiler hydrazine tank	Liquid	Determine quality of hydrazine	None
J. Standby Diesel Generator Fuel Oil Storage and Transfer System			
1. Fuel oil storage tanks	Liquid	Determine quality of fuel oil	9.5.4-2
K. Make Up Demineralizer System			
1. Cation units discharge	Liquid	Monitor cation unit performance	None
2. Acid feed pumps discharge	Liquid	Monitor cation unit performance	None
3. Heated water storage tank	Liquid	Monitor water quality	None
4. Anion units discharge	Liquid	Monitor anion unit performance	None
5. Mixed bed units discharge	Liquid	Monitor mixed bed unit performance	None
6. Prover tank inlet	Liquid	Determine water quality	None
7. Reverse osmosis banks	Liquid	Monitor performance	None
8. Prover tank transfer pumps discharge	Liquid	Monitor water quality	None

1. The analysis and frequency of grab samples will be in accordance with plant chemistry specification.

TABLE 9.3-4 (Continued)

LOCAL GRAB SAMPLES[1]

Location	Description	Purpose	UFSAR Figure Reference
Chemical Monitoring (Continued)			
L. Chemical and Volume Control System			
1. Boric acid tanks	Liquid	Monitor tank chemistry	9.3.4-5
2. Boric acid batching tank	Liquid	Monitor tank chemistry	9.3.4-5
3. Volume control tank	Gas	Monitor tank chemistry	9.3.4-3
4. Concentrated boric acid	Liquid	Monitor chemistry	9.3.4-5
M. Safety Injection System			
1. SIS test line sample	Liquid	Monitor check valve leakage	6.3-4
N. Component Cooling Water System			
1. CCW pumps suction	Liquid	Monitor water quality	9.2.2-1 9.2.2-2 9.2.2-3
O. Containment Spray System			
P. Reactor Coolant Pump Oil Changing System			
1. Reactor coolant pump oil	Liquid	Monitor oil quality	None
Q. CLRT Pressurization System			
1. Refrigerated air dryer outlet	Gas	Determine air quality	6.2.6-1

1. The analysis and frequency of grab samples will be in accordance with plant chemistry specification.

TABLE 9.3-4 (Continued)

LOCAL GRAB SAMPLES[1]

Location	Description	Purpose	UFSAR Figure Reference
Chemical Monitoring (Continued)			
R. Auxiliary Boiler Condensate and Feed Water System			
1. Auxiliary boiler deaerator	Liquid	Determine water quality	9.5.9-1
S. Oily Waste System			
1. Tricellerator inlet and discharge	Liquid	Monitor tricellerator performance	None
2. Effluent booster pump discharge	Liquid	Monitor effluent	None
T. Steam Generator Blowdown System			
1. Steam generator recirculation pumps discharge	Liquid	Monitor water quality	10.4.8-1
2. SGBD prefilters inlet and outlet	Liquid	Monitor filter performance	10.4.8-3
U. Condensate Polishing System			
1. Cation service vessels	Liquid	Determine vessel performance	10.4.6-3
2. Mixed bed service vessels	Liquid	Determine vessel performance	10.4.6-3
3. Cation regeneration vessels inlet and outlet	Liquid	Determine vessel performance	10.4.6-4
4. Anion rinse/mix and hold vessel inlet and outlet	Liquid	Determine vessel performance	10.4.6-4
5. Cation resin storage vessel	Liquid	Monitor resin quality	10.4.6-4
6. Hot water tanks outlet	Liquid	Monitor water quality	10.4.6-4
7. Regeneration water pumps discharge	Liquid	Monitor water quality	10.4.6-4

1. The analysis and frequency of grab samples will be in accordance with plant chemistry specification.

TABLE 9.3-4 (Continued)

LOCAL GRAB SAMPLES[1]

Location	Description	Purpose	UFSAR Figure Reference
Chemical Monitoring (Continued)			
8. Cation acid pumps discharge	Liquid	Monitor acid quality	10.4.6-4
9. Cation LTDS tank	Liquid	Monitor tank chemistry	10.4.6-5
10. Mixed bed LTDS tank	Liquid	Monitor tank chemistry	10.4.6-5
11. Cation HTDS tank	Liquid	Monitor tank chemistry	10.4.6-5
12. Mixed bed HTDS tanks	Liquid	Monitor tank chemistry	10.4.6-5
V. Boron Recycle System			
1. Recycle holdup tanks	Liquid	Determine boron content of tank	9.3.4-6
2. Recycle evaporator condensate demineralizer	Liquid	Evaluate demineralizer performance	9.3.4-7
3. Boron recycle evaporator package			
a. concentrate	Liquid	Determine boron content	9.3.4-7
b. distillates	Liquid	Monitor water quality	9.3.4-7
W. Chilled Water System			
1. Chilled water	Liquid	Determine water chemistry	9.4.5-5 9.4.1-5

1. The analysis and frequency of grab samples will be in accordance with plant chemistry specification.

TABLE 9.3-5

PROCESS AND POST-ACCIDENT SAMPLING SYSTEMS: DESIGN CODES AND STANDARDS

Sample/Component Description	Seismic Design	Nuclear Safety Class	Applicable Design Codes
I. .Primary Process Samples			
A. Sample Lines Penetrating Containment			
1. Sample piping and valves from inside Containment up to and including the sample line isolation valves outside the Containment	Seismic Category I	Class 2	ASME B&PV Code, Section III
2. Sample piping and valves downstream of the isolation valve outside the Containment to the sample sink, sample coolers, and sample vessels	Nonseismic	NNS	Piping & valves: ANSI B31.1.0 Sample coolers & sample vessels: ASME VIII
B. Sample Lines Not Penetrating Containment			
1. Sample piping and valves up to and including the first sample line isolation valve	Seismic Category I	Class 2 and Class 3	ASME Section III
2. Sample piping and valving downstream of first isolation valve	Nonseismic	NNS	ANSI B31.1.0
3. Sample vessels	Nonseismic	NNS	ASME Section VIII, Division I
II. Secondary Process Samples			
1. Sample piping and valves	Nonseismic	NNS	ANSI B31.1.0
2. Sample coolers	Nonseismic	NNS	ASME Section VIII
III Post-Accident Samples			
1. Sample piping and valves up to and including the sample line Containment isolation valve.	Seismic Categor I	Class 2	ASME B&PV Code, Section III
2. Sample piping and valving downstream of isolation valve	Nonseismic	NNS	ANSI B31.1.0
3. Sample coolers	Nonseismic	NNS	ASME Section VIII, Division I

TABLE 9.3-8

SUMP AND SUMP PUMP PARAMETERS

Containment Normal Sump	
Quantity/Type	1/Duplex submersible pump
Capacity (gal/min)	50 each pump
Containment Secondary Sump	
Quantity/Type	1/Simplex submersible pump
Capacity (gal/min)	20
Containment Penetration Area Sump	
Quantity/Type	1/Duplex pump
Capacity (gal/min)	50
RHT 1A & 1B Compartments Sumps	
Quantity/Type	1/Simplex submersible pump (Each)
Capacity (gal/min)	50
RMWST Compartment Sump	
Quantity/Type	1/Simplex submersible pump
Capacity (gal/min)	50
RWST Compartment Sump	
Quantity/Type	1/Simplex submersible pump
Capacity (gal/min)	50
Transfer Cart Area Sump (FHB Sump No. 3)	
Quantity/Type	1/Simplex submersible pump
Capacity (gal/min)	50

TABLE 9.3-8 (Continued)

SUMP AND SUMP PUMP PARAMETERS

CCW Sump

Quantity/Type	1/Simplex pump
Capacity (gal/min)	75

Charging Pump Compartment Sump

Quantity/Type	1/Duplex submersible pump
Capacity (gal/min)	50 each pump

MAB Floor Drain Sumps 1, 2, 3, & 4

Quantity/Type	1/Duplex pump (each)
Capacity (gal/min)	50 each pump

FHB Sump No. 2

Quantity/Type	1/Duplex submersible pump
Capacity (gal/min)	50 each pump

SIS and CSS Pump Compartment 1A, 1B, & 1C Sumps

Quantity/Type	1/Duplex submersible pump (Each)
Capacity (gal/min)	50 each pump

Elevator Shaft No. 5 Sump

Quantity/Type	1/Simplex submersible pump
Capacity (gal/min)	85

FHB Sump Tank No. 1

Quantity/Type	1/Duplex pump
Capacity (gal/min)	50 each pump

TABLE 9.3-8 (Continued)

SUMP AND SUMP PUMP PARAMETERS

Essential Cooling Water Sump Pump	
Quantity/Type	1/Duplex pump
Capacity (gal/min)	390 each pump
Fire Protection System Sump Pump	
Quantity/Type	1/Duplex
Capacity (gal/min)	150 each pump
Condenser Pit Sump Pump	
Quantity/Type	2/Duplex
Capacity (gal/min)	300 each pump
Turbine-Generator Building Sump Pumps	
Quantity/Type	3/Duplex
Capacity (gal/min)	200 each pump
Elevator Shaft Sump Pumps	
Quantity/Type	2/Simplex
Capacity (gal/min)	40
FHB Sump Tank No. 1	
Quantity/Type	1/Duplex
Capacity (gal/min)	50 each pump

TABLE 9.3-9

CHEMICAL AND VOLUME CONTROL SYSTEM – DESIGN PARAMETERS

General

Seal water supply flow rate, for 4 reactor coolant pumps, nominal, gal/min	32
Seal water return flow rate, for 4 reactor coolant pumps, nominal, gal/min	12
Letdown flow:	
Normal, gal/min	100
Maximum, gal/min	198
Charging flow (excludes seal water):	
Normal, gal/min	80
Maximum, gal/min	230
Temperature of letdown reactor coolant entering system, °F	570
Temperature of charging flow directed to Reactor Coolant System, °F	530
Temperature of effluent directed to Boron Recycle System, °F	115
Shutdown purification flow, gal/min	450
Minimum amount of 4% boric acid solution required to meet cold shutdown requirements shortly after full-power operation, gal	27,000 (modes 1 through 4) 3,200 (modes 5 and 6)
Maximum pressurization required for hydrostatic testing of Reactor Coolant System, psig	3,107
Concentrated boric acid design flow rate, gal/min	30

TABLE 9.3-10

CHEMICAL AND VOLUME CONTROL SYSTEM – PRINCIPAL COMPONENT DATA SUMMARY

Positive Displacement Pump	
Number	1
Design pressure, psig	3,200
Design temperature, °F	250
Design flow, gal/min	35
Design head, ft	5,800
Material	Austenitic stainless steel
Maximum operating pressure, psig (for Reactor Coolant System hydrotest purposes)	3,125
Centrifugal Charging Pump	
Number	2
Design pressure, psig	3,100
Design temperature, °F	250
Design flow, gal/min	160
Design head, ft	5,800
Material	Austenitic stainless steel
Boric Acid Transfer Pump	
Number	2
Design pressure, psig	150
Design temperature, °F	250
Design flow, gal/min	125
Design head, ft	235
Material	Austenitic stainless steel
Reactor Coolant Purification Pump	
Number	1
Design pressure, psig	600
Design temperature, °F	400
Design flow, gal/min	450
Design head, ft	575
Material	Austenitic stainless steel

TABLE 9.3-10 (Continued)

CHEMICAL AND VOLUME CONTROL SYSTEM – PRINCIPAL COMPONENT DATA SUMMARY

Chiller Pump

Number		2
Design pressure, psig		150
Design temperature, °F		200
Design flow, gal/min		820
Design head, ft		200
Material		Carbon steel

Regenerative Heat Exchanger

Number		1
Heat transfer rate at design conditions, Btu/hr		27.5×10^6
	Shell Side	Tube Side
Design pressure, psig	2,485	3,100
Design temperature, °F	650	650
Fluid	Borated reactor coolant	Borated reactor coolant
Material	Austenitic stainless steel	Austenitic stainless steel
	Shell Side (Letdown)	Tube Side (Charging)
Flow, lb/hr	49,700	39,700
Inlet temperature, °F	570	130
Outlet temperature, °F	~265	~530

Letdown Heat Exchanger

Number		1
Heat transfer rate at design conditions, Btu/hr		33.5×10^6
	Shell Side (Letdown)	Tube Side
Design pressure, psig	150	600
Design temperature, °F	250	400
Fluid	Component cooling water	Borated reactor coolant
Material	Carbon steel	Austenitic stainless steel

TABLE 9.3-10 (Continued)

CHEMICAL AND VOLUME CONTROL SYSTEM – PRINCIPAL COMPONENT DATA SUMMARY

Shell Side	Design	Normal
Flow, lb/hr	1,035,000	179,300
Inlet temperature, °F	105	105
Outlet temperature, °F	137	~148

Tube Side (Letdown)		
Flow, lb/hr	124,200	49,700
Inlet temperature, °F	380	~270
Outlet temperature, °F	115	115

Excess Letdown Heat Exchanger

Number	1
Heat transfer rate at design conditions, Btu/hr	6.55×10^6

	Shell Side	Tube Side
Design pressure, psig	150	2,485
Design temperature, °F	250	650
Design flow, lb/hr	163,900	14,900
Inlet temperature, °F	105	570
Outlet temperature, °F	145	160
Fluid	Component cooling water	Borated reactor coolant
Material	Carbon steel	Austenitic stainless steel

Seal Water Heat Exchanger

Number	1
Heat transfer rate at design conditions, Btu/hr	2.4×10^6

	Shell Side	Tube Side
Design pressure, psig	150	150
Design temperature, °F	250	250
Design flow, lb/hr	186,000	42,200
Inlet temperature, °F	105	172
Outlet temperature, °F	118	115
Fluid	Component cooling water	Borated reactor coolant
Material	Carbon steel	Austenitic stainless steel

TABLE 9.3-10 (Continued)

CHEMICAL AND VOLUME CONTROL SYSTEM – PRINCIPAL COMPONENT DATA SUMMARY

Moderating Heat Exchanger

Number		1
Heat transfer rate at design conditions, Btu/hr		5.26×10^6
	Shell Side	Tube Side
Design pressure, psig	300	300
Design temperature, °F	200	200
Design flow, lb/hr	124,200	124,200
Design inlet temperature (boron storage mode), °F	50	115
Design outlet temperature (boron storage mode), °F	92.5	72.6
Inlet temperature (boron release mode)	140	115
Outlet temperature (boron release mode)	123.7	131.4
Material	Austenitic stainless steel	Austenitic stainless steel

Letdown Chiller Heat Exchanger

Number		1
Heat transfer rate at design conditions (boron storage mode), Btu/hr		3.43×10^6
	Shell Side	Tube Side
Design pressure, psig	150	300
Design temperature, °F	200	200
Design flow (boron storage mode), lb/hr	371,000	124,200
Design inlet temperature (boron storage mode), °F	39	72.6
Design outlet temperature (boron storage mode), °F	48.3	45
Flow (boron release mode), lb/hr	By manufacturer	124,200
Inlet temperature (boron release mode), °F	39	123.7
Outlet temperature (boron release mode), °F	By manufacturer	105
Material	Carbon steel	Austenitic stainless steel

TABLE 9.3-10 (Continued)

CHEMICAL AND VOLUME CONTROL SYSTEM – PRINCIPAL COMPONENT DATA SUMMARY

Letdown Reheat Heat Exchanger

Number		1
Heat transfer rate at design conditions, Btu/hr		3.09×10^6
	Shell Side	Tube Side
Design pressure, psig	300	600
Design temperature, °F	200	400
Design flow, lb/hr	124,200	109,300
Inlet temperature, °F	115	260
Outlet temperature, °F	140	232
Material	Austenitic stainless steel	Austenitic stainless steel

Concentrated Boric Acid Sample Cooler

General:

Number (per unit)	1
Type	Shell and coil
Heat transfer rate @ design conditions, Btu/hr	18,700
Shell side: (CCW)	
Design pressure, psig	150
Design temperature, °F	250
Pressure loss @ design flow conditions, psi	36
Material of construction	Carbon steel
Tube side: (process fluid)	
Design pressure, psig	150

Volume Control Tank

Number	1
Volume, ft^3	600
Design pressure, psig	85
Design temperature, °F	250
Material	Austenitic stainless steel

Boric Acid Tank

Number	2
Design pressure, psig	Atmospheric
Design temperature, °F	200
Material	Austenitic stainless steel

TABLE 9.3-10 (Continued)

CHEMICAL AND VOLUME CONTROL SYSTEM – PRINCIPAL COMPONENT DATA SUMMARY

Batching Tank

Number	1
Capacity, gal	800
Design pressure	Atmospheric
Design temperature, °F	350
Material	Austenitic stainless steel

Chemical Mixing Tank

Number	1
Capacity, gal	5
Design pressure, psig	150
Design temperature, °F	200
Material	Austenitic stainless steel

Chiller Surge Tank

Number	1
Volume, gal	500
Design pressure, psig	1
Design temperature, °F	200
Material	Carbon steel

Mixed-Bed Demineralizer

Number	2
Design pressure, psig	300
Design temperature, °F	250
Design flow, gal/min	250
Resin volume, each, ft^3	75
Material	Austenitic stainless steel

Cation-Bed Demineralizer

Number	2
Design pressure, psig	300
Design temperature, °F	250
Design flow, gal/min	250
Resin volume, ft^3	75
Material	Austenitic stainless steel

TABLE 9.3-10 (Continued)

CHEMICAL AND VOLUME CONTROL SYSTEM – PRINCIPAL COMPONENT DATA SUMMARY

Thermal Regeneration Demineralizer

Number	5
Design pressure, psig	300
Design temperature, °F	250
Design flow, gal/min	120
Resin volume, ft^3	90
Material	Austenitic stainless steel

Concentrated Boric Acid Polishing Demineralizer (Cation Bed)

Number (per unit)	1
Type	Flushable
Design temperature, °F	200
Design pressure, psig	300
Resin volume, ft^3	30
Resin type	Strong acid type cation
Design flow, gal/min	30
Pressure drop @ design flow, psi	2.5 psi
Material of construction	Austenitic stainless steel
ANSI Safety Class	NNS

Reactor Coolant Filter

Number	2
Design pressure, psig	300
Design temperature, °F	250
Design flow, gal/min	250
Particle retention	98% of 25-micron size (or smaller)
Material (vessel)	Austenitic stainless steel

Letdown Filter

Number	2
Design pressure, psig	300
Design temperature, °F	250
Design flow, gal/min	250
Particle retention	98% of 5-micron size (or smaller)
Material (vessel)	Austenitic stainless steel

TABLE 9.3-10 (Continued)

CHEMICAL AND VOLUME CONTROL SYSTEM – PRINCIPAL COMPONENT DATA SUMMARY

Seal Water Injection Filter

Number	2
Design pressure, psig	3,100
Design temperature, °F	250
Design flow, gal/min	80
Particle retention	98% of 5-micron size (or smaller)
Material (vessel)	Austenitic stainless steel

Seal Water Return Filter

Number	1
Design pressure, psig	300
Design temperature, °F	250
Design flow, gal/min	250
Particle retention	98% of 25-micron size (or smaller)
Material (vessel)	Austenitic stainless steel

Boric Acid Filter

Number	1
Design pressure, psig	300
Design temperature, °F	250
Design flow, gal/min	250
Particle retention	98% of 25-micron size (or smaller)
Material (vessel)	Austenitic stainless steel

Concentrated Boric Acid Polishing Filter

Number (per unit)	1
Type	Disposable cartridge
Design pressure, psig	300
Design temperature, °F	250
Design flow, gal/min	30
Design flow area, ft^2	16.3
Pressure drop @ design flow (clean), psi	9
Particle retention	98% of 0.5-micron size (or smaller)
Maximum pressure differential (fouled), psi	35
Material of construction	Austenitic stainless steel
ANSI safety class	NNS

TABLE 9.3-10 (Continued)

CHEMICAL AND VOLUME CONTROL SYSTEM – PRINCIPAL COMPONENT DATA SUMMARY

Letdown Orifice	30 gal/min	85 gal/min	115 gal/min
Number	1	1	1
Design flow, lb/hr	14,900	49,700	74,500
Differential pressure at design flow, psia	1,525	1,525	1,525
Design pressure, psig	2,485	2,485	2,485
Design temperature, °F	650	650	650
Material	Austenitic stainless steel	Austenitic stainless steel	Austenitic stainless steel

Chiller

Number	1
Capacity, Btu/hr	3.43×10^6
Design flow, gal/min	785
Inlet temperature, °F	47.8
Outlet temperature, °F	39

Pulsation Dampener

Number	1
Design Pressure, psig	3200
Design Temperature, °F	250
Capacity, gal/min	35
Material	Stainless steel

Suction Stabilizer

Number	1
Design Pressure, psig	240
Design Temperature, °F	200
Capacity, gal/min	35
Material	Stainless steel

TABLE 9.3-11

BORON RECYCLE SYSTEM
PRINCIPAL COMPONENT DATA SUMMARY

Recycle Evaporator Feed Pumps

Number	2
Design pressure, psig	150
Design temperature, °F	250
Design flow, gal/min	35/100
Design head, ft	250/200
Material	Stainless steel

Recycle Holdup Tanks

Number	2
Capacity, gal	85,00
Design pressure	Atmospheric
Design temperature, °F	200
Material	Stainless steel

Recycle Evaporator Reagent Tank

Number	1
Capacity, gal	5
Design pressure, psig	150
Design temperature, °F	200
Material	Stainless steel

Recycle Evaporator Feed Demineralizers

Number	2
Design pressure, psig	300
Design temperature, °F	250
Design flow, gal/min	250
Resin volume, ft^3	75
Material	Stainless steel

Recycle Evaporator Condensate Demineralizers

Number	1
Design pressure, psig	300
Design temperature, °F	250
Design volume, gal/min	120
Resin volume, ft^3	30
Material	Stainless steel

TABLE 9.3-11 (Continued)

BORON RECYCLE SYSTEM
PRINCIPAL COMPONENT DATA SUMMARY

Recycle Evaporator Feed Filter

Number	2
Design pressure, psig	300
Design temperature, °F	250
Design flow, gal/min	250
Particle retention	98% of 5-micron size (or smaller)
Material (vessel)	Stainless steel

Recycle Evaporator Condensate Filter

Number	1
Design pressure, psig	200
Design temperature, °F	250
Design flow, gal/min	250
Particle retention	98% of 25-micron size (or smaller)
Material (vessel)	Stainless steel

Recycle Evaporator Concentrates Filter

Number	1
Design pressure, psig	200
Design temperature, °F	250
Design flow, gal/min	250
Particle retention	98% of 2-micron size (or smaller)
Material (vessel)	Stainless steel

Recycle Evaporator Package

Number	1
Design flow, gal/min	15
Concentration of concentrate (boric acid), weight percent	4
Concentration of condensate	<10 ppm boron as H_3BO_3
Material	Stainless steel

Recycle Evaporator Sample Preconditioning Demineralizer

Number	1
Design pressure, psig	30 psig
Design temperature, °F	120°F
Design flow, cm^3/min	200
Resin volume, cm^3	2550
Resin type	Strong base disposable resin cartridge
Material	Polycarbonate plastic

TABLE 9.3-12

CHEMICAL AND VOLUME CONTROL SYSTEM
FAILURE MODES AND EFFECTS ANALYSIS

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Safety Function Capability	General Remarks
Motor-operated valve LCV-465 or LCV-468 (normally open)	Close to isolate RCS on pressurizer low-level	1-5	Fails to close	Position indication	Non – Redundant valve in series closes	
Motor-operated valve MOV-0112B or MOV-0113A (normally open	Close to isolate VCT on VCT low-low level or SI signal	1-5	Fails to close	Position indication ESF status monitoring	None - Redundant valve in series closes	
Motor-operated valve MOV-0112C or MOV 0113B (normally closed)	Open on VCT low-low level or SI signal to ensure charging suction is maintained	1-5	Fails to open	Position indication ESF status monitoring	None - Redundant valve in parallel opens	A failure modes and effects analysis for the charging and boration functions of the CVCS is presented in Table 5.4.A-2
Motor-operated valve MOV-0033A (valve MOV-0033B, MOV-0033C, MOV-0033D analogous) (normally open)	Close to provide containment isolation	1-5	Fails to open	Position indication ESF status monitoring	None - Check valve inside containment provides isolation	

* Plant Modes

1. Power Operation
2. Startup
3. Hot Standby
4. Hot Shutdown
5. Cold Shutdown
6. Refueling

TABLE 9.3-12 (Continued)

CHEMICAL AND VOLUME CONTROL SYSTEM
FAILURE MODES AND EFFECTS ANALYSIS

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Safety Function Capability	General Remarks
Air operated valve FV-0011 (normally open)	Close to isolate RCS on containment phase A isolation signal or pressurizer low level	1-5	Fails to close	Position indication ESF status monitoring	Valve MOV-0023 and MOV-0024 provide containment isolation and the relief valve will lift, discharging to the PRT until the letdown line is isolated either by operator action or automatically due to low pressurizer level closing LCV-465 and LCV-468	RCS isolation is not a safety requirement but the design feature prevents flashing in the regenerative heat exchangers

* Plant Modes

1. Power Operation
2. Startup
3. Hot Standby
4. Hot Shutdown
5. Cold Shutdown
6. Refueling

TABLE 9.3-12 (Continued)

CHEMICAL AND VOLUME CONTROL SYSTEM
FAILURE MODES AND EFFECTS ANALYSIS

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Safety Function Capability	General Remarks
Check valve CV0034A (valves CV0034B, CV0034C, CV0034D, XCV0026 analogous)	Close to provide containment isolation	1-5	Fails to close	None	None - Motor –operated valve in series closes to provide isolation	
Motor–operated valve MOV-0077 or MOV-0079 (normally open)	Close to provide containment isolation	1-5	Fails to close	Position indication ESF status monitoring	None - Redundant valve closes to provide isolation	
Motor–operated valve MOV-0025 (normally open)	Close to provide containment isolation	1-5	Fails to close	Position indication ESF status monitoring	None - Check valve in series inside containment closes to provide isolation	
Motor-operated valve MOV-0023 or MOV-0024 (normally open)	Close to provide containment isolation	1-5	Fails to close	Position indication ESF status monitoring	None - Redundant valve in series closes to provide isolation	

* Plant Modes

1. Power Operation
2. Startup
3. Hot Standby
4. Hot Shutdown
5. Cold Shutdown
6. Refueling

TABLE 9.3-12 (Continued)

CHEMICAL AND VOLUME CONTROL SYSTEM
FAILURE MODES AND EFFECTS ANALYSIS

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Safety Function Capability	General Remarks
ESF Actuation System Train A (Trains B & C analogous)	Provide actuation signals as required to safety-related components	1-6	Fails to generate and send actuation signals	Loss of power or actuation train in test is alarmed by ESF status monitoring. Individual bistables used to generate actuation signals are individually provided with lights and computer inputs, and combined with other similar inputs (for same signal), are alarmed on annunciator, all on main control board	None - System safety function is assured by actuation of other trains	Indication that one train of equipment is not operating is provided to the operator. Systems can then be started manually
Class 1E AC Power Train A (Trains B & C analogous)	Provide power to Train A AC components	1-6	Loss of power on bus	Bus undervoltage alarms, ESF status monitoring for ESF Diesel Generator System and components, ESF monitoring for system and AC components	None - Trains B & C provide system safety capability	

* Plant Modes

1. Power Operation
2. Startup
3. Hot Standby
4. Hot Shutdown
5. Cold Shutdown
6. Refueling

TABLE 9.3-12 (Continued)

CHEMICAL AND VOLUME CONTROL SYSTEM
FAILURE MODES AND EFFECTS ANALYSIS

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Safety Function Capability	General Remarks
Channel I DC Power (Train A) (Channels II, III, and IV) (Trains D, B, and C analogous)	Provide DC power to Channel I components	1-6	Loss of DC power	ESF monitoring on UPS failure, DC trouble alarm, ESF monitoring for pump (not running, no control power)	None - Redundant trains provide system safety capability	Pump status light off
Instrument Air (nonsafety)	None	1-6	Instrument air lost	Header pressure indication and alarms	None - Loss of instrument air causes air-operated components to go to their safety position	

* Plant Modes

1. Power Operation
2. Startup
3. Hot Standby
4. Hot Shutdown
5. Cold Shutdown
6. Refueling

TABLE 9.3-14

LINES WITH EXTERNAL DISCHARGE CAPABILITY
FROM CATEGORY I BUILDINGS [2,3]

Area	System	Line Size, In.	Ref. Dwg. No.	Remarks [1]
MEAB	ECWD	6	9-B-0120	
MEAB	SS	6	9-B-0128	Note 4
MEAB	SS	6	9-B-0154	
MEAB	FDS	4	9-B-0155	
MEAB	FDS	6	9-B-0157	
MEAB	FDS	6	9-B-0158	
MEAB	FDS	6	9-B-0159	
MEAB	FDS	6	9-B-0160	
MEAB	FDS	4	9-B-0154	
DGB	OW	8	9-B-0171	3 lines
RCB	RVDS	2	9-F-5030	
Tendon Gallery	FDS	4	9-B-0203	
IVC	OW	2	9-B-0176	4 lines
FHB	DR	1 ½	9-V-0012	

1. All drains are provided with check valves.

2. With the exception of the FHB HVAC chiller coil condensate drain, FHB drains are pumped into the MEAB.

3. ECWIS has no drains leaving the building.

4. Cast iron (CI) pipe, gravity flow systems with CI swing check valves.

9.4 AIR-CONDITIONING, HEATING, COOLING, AND VENTILATING SYSTEMS

The objective of the plant Heating, Ventilating, and Air-Conditioning (HVAC) Systems is to provide ambient air conditions for personnel comfort, health and safety, and efficient equipment operation and integrity by controlling the thermal environment and airborne radioactivity in the plant. The HVAC systems are described in detail in Sections 9.4.1 through 9.4.8. Parameters of plant HVAC Systems are summarized in Table 9.4-1. HVAC Systems components design data are summarized in Tables 9.4-2.1 through 9.4-2.8. The HVAC Systems single-failure analyses are summarized in Tables 9.4-5.1 through 9.4-5.8. Space temperature, pressure, and humidities in the plant during different modes of operation are indicated in Table 3.11-1. HVAC equipment safety classification is summarized in Section 3.2. Plant main exhaust air ductwork data are summarized in Table 9.4-3. The general flow characteristics and system configuration of HVAC Systems are shown on all the figures between 9.4-l and 9.4.8-l.

9.4.1 Electrical Auxiliary Building HVAC Systems

The following systems are included within the Electrical Auxiliary Building (EAB) HVAC Systems:

1. Control Room (CR) Envelope HVAC System

2. EAB Main Area HVAC System

3. Technical Support Center (TSC) HVAC System

4. Essential Chilled Water System

9.4.1.1 Design Bases. The systems which comprise the EAB HVAC Systems are designed as follows:

1. CR Envelope HVAC System is designed to:

    a. Assure habitability of the CR envelope and permit safe shutdown of the plant as may be required under any normal or emergency conditions.

    b. Maintain ambient temperature conditions to provide operator comfort and to satisfy environmental requirements of equipment. The design bases of ambient conditions, safety class, and seismic category are listed in Table 9.4-1 and Section 3.2.

    c. Maintain the CR envelope at positive pressure to minimize any inleakage of possible contamination from the outside.

    d. Satisfy the design requirements of limiting dose to CR operators following the Design Basis Accident (DBA) in accordance with General Design Criterion (GDC) 19 of 10CFR50 Appendix A.

    Instrumentation and controls are provided to detect abnormal conditions such as smoke and high radioactive concentrations in the makeup air. Two leak tight isolation dampers in series are provided in the outside air ductwork for each main air handling unit (AHU) to isolate the

CR envelope and stop outside air makeup in the event of smoke detection at the outside air intake. Operation, monitoring, and control of these systems are provided in the CR.

Equipment, motors, and controls with safety functions (except for outside air and smoke) are supplied from Class 1E power sources and are separated and redundant to meet the single failure criterion. The smoke monitors are served by a non-Class 1E uninterruptible power source (UPS) and are redundant.

Surveillance of airborne radioactivity levels of the outside makeup air to the supply system is provided by the CR ventilation inlet air radiation monitors. On a high gaseous radioactivity or safety injection (SI) signal, CR makeup is automatically diverted through CR air makeup filter units. These units contain high-efficiency particulate air (HEPA) and charcoal filters.

This safety-related system consists of three 50-percent-capacity redundant trains, powered by three redundant, independent, Engineered Safety Features (ESF) busses and provided with chilled water for the AHU from a separate essential chilled water train corresponding to the same division. Thus the single active failure criterion is met.

The physical separation criteria applicable to the CR Envelope HVAC System are specified in Section 3.5 for separation and missile protection and in Section 3.6 for protection against the dynamic effects associated with postulated rupture of piping. Common supply and return air ductwork is used with a crosstie between the three trains and is provided with necessary isolation dampers to isolate the nonoperating train.

In case of fire within this area, provision is made for smoke purge as described in Section 9.4.1.3. The design of this system also complies with GDCs 2, 3, and 4.

A high temperature switch is located in the main CR to annunciate an alarm should the space temperature exceed the predetermined setpoint of the temperature switch. Inadvertent closure of a fire damper serving this area would initiate the alarm. The alarm alerts the CR operator and appropriate measures can be taken to manually reopen the failed fire damper to restore the design air flow. Temperature excursions in spaces contiguous to the main CR, yet within the envelope, can be identified by CR personnel or by high temperature alarms located in the rooms (i.e., Relay Room, Computer Room). Should this condition occur, suitable measures can be taken to manually reopen the damper.

Environmental design considerations relating to CR habitability following an accident are discussed in Section 6.4.

Regulatory Guide (RG) 1.52 and Oak Ridge National Laboratory (ORNL) publication ERDA 76-21, "Design, Construction and Testing of High-Efficiency Air Filtration Systems for Nuclear Application", are used as guides in the detail design of the CR envelope HVAC.

2. EAB Main Area HVAC System is designed to maintain ambient temperature conditions to provide operator comfort and to satisfy environmental requirements of equipment. The design bases of ambient conditions, safety class, and seismic categories are listed in Table 9.4-1 and Section 3.2.

Equipment, motors, and controls with safety functions are supplied from Class 1E power sources and are separated and redundant to meet the single failure criterion.

This safety-related system consists of three 50-percent-capacity redundant trains, powered by three redundant independent, ESF busses and provided with chilled water for the AHU from a separate essential chilled water train corresponding to the same division. Thus the single active failure criterion is met.

The physical separation criteria applicable to the EAB Main Area HVAC system are specified in Section 3.5 for separation and missile protection and in Section 3.6 for protection against the dynamic effects associated with postulated rupture of piping. Supply and return air ductwork is separated by trains, with the exception of common supply/return risers between the three trains which are provided with necessary isolation dampers to isolate the nonoperating train.

In case of fire within this area, provision is made for smoke purge as described in Section 9.4.1.3. The design of this system also complies with GDCs 2, 3, and 4.

High temperature switches have been placed in critical areas on each level. These switches are provided with CR annunciation should the ventilation air be interrupted by the inadvertent closure of a fire damper and the resulting space temperature exceeds the temperature switch alarm setpoint. The annunciation alerts the CR operator and appropriate investigative measures can be implemented to reopen the failed fire damper to restore the design air flow. The HVAC equipment room fire dampers can only effect one train of the HVAC system and the remaining two safety-related trains are available to perform the system's safety function. Area fire dampers isolate the affected spaces only and do not inhibit the system's ability to provide the systems safety function.

American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) Standard 52 and ORNL publication ERDA 76-21, "Design, Construction and Testing of High-Efficiency Air Filtration Systems for Nuclear Application" are used as guides in the detail design of the EAB main area HVAC.

3. Technical Support Center HVAC System is designed to:

   a. Maintain the TSC in a habitable condition as may be required under any normal or emergency condition. (For the TSC habitability requirements see Appendix 7A, item S.8).

   b. Maintain ambient temperature conditions to provide personnel comfort and to satisfy environmental requirements of equipment.

   The design bases of ambient conditions, safety classes, and seismic categories are listed in Table 9.4-1 and Section 3.2.

   c. Maintain the TSC at positive pressure to minimize any inleakage of possible contamination from the outside.

d. Satisfy the design requirements of limiting dose to the occupants following the DBA in accordance with GDC 19 of 10CFR50 Appendix A.

Instrumentation and controls are provided to detect abnormal conditions such as smoke and high radioactive concentrations in the makeup air. Makeup air for the TSC, EAB main area, and CR envelope is provided from the same outside air intake and monitoring is provided at that point. A leaktight isolation damper is provided to isolate the TSC and stop outside air makeup in the event of smoke detection at the outside air intake. Operation, monitoring, and control of these systems are provided at a local panel in the TSC HVAC Room.

Equipment, motors, and controls with essential functions are supplied from a reliable source of power backed up by the TSC diesel generator (DG).

In case of fire within this area, provision is made for smoke purge similar to CR and EAB HVAC Subsystems above.

RG 1.140 and ORNL publication ERDA 76-21, "Design, Construction and Testing of High-Efficiency Air Filtration Systems for Nuclear Application" are used as guides in the detail design of the TSC HVAC.

4. Essential Chilled Water System is designed to provide chilled water to certain supply AHUs under any normal or emergency condition. For the AHUs being supplied, see Section 9.4.1.2, Item (4).

The safety class (SC) and seismic category are listed in Section 3.2.

This safety-related system consists of three 50-percent-capacity redundant trains, powered by three redundant, independent, ESF busses. Thus the single active failure criterion is met.

The physical separation criteria applicable to the Essential Chilled Water System are specified in Section 3.5 for separation and missile protection and in Section 3.6 for protection against the dynamic effects associated with postulated rupture of piping.

The Essential Chilled Water System dehumidifies the air that passes over the supply cooling coil to maintain the relative humidity below 70% in the CRE HVAC system. This ensures the assumed filter efficiencies for iodine removal used in the postulated Chapter 15 accidents (see Appendix l5D). Because of this cooling, operation of the heaters in the CRE HVAC Makeup filters are not necessary to maintain the proper humidity over the charcoal beds, even assuming the pressurization air is at 100% RH.

9.4.1.2 System Description. The EAB HVAC System consists of the following four major systems. The areas served by these HVAC Systems are shown on the general arrangement drawings listed as Figures 1.2-26 through 1.2-30 on Table 1.2-1.

1. CR Envelope HVAC System serves the CR envelope areas described in Section 6.4.

2. EAB Main Area HVAC System serves all the following major areas in EAB.

a. Battery and distribution panel rooms

b. Electrical switchgear rooms

c. Cable spreading rooms

d. Distribution panel rooms

e. Power cable vaults

f. Motor generator set room

g. Storage rooms

h. HVAC system equipment rooms

i. Miscellaneous electric equipment room

j. Miscellaneous offices

k. Radiation monitoring room

l. Electrical penetration areas

m. Auxiliary Shutdown Panel (ASP) area

n. Central Alarm Station (Unit 1 only)

3. <u>Technical Support Center (TSC) HVAC System</u> serves the following TSC areas within the EAB.

   a. Computer room

   b. Communication room

   c. Nuclear Regulatory Commission (NRC) room

   d. Operations room

   e. TSC HVAC equipment room

   f. Storage rooms

   g. Toilets

   h. Conference and break rooms

The above three systems are independent of each other with the exception of common outside air intake. The system configuration is shown on Figures 9.4.l-l to 9.4.l-3 and principal system components are listed and described in Table 9.4-2.l.

4. Essential Chilled Water System provides chilled water to the following safety-related AHUs.

   a. EAB main supply AHUs in EAB

   b. CR envelope AHUs in EAB

   c. Electrical penetration space emergency AHUs in EAB

   d. Reactor makeup water (RMW) pump cubicle AHUs in Mechanical Auxiliary Building (MAB)

   e. Boric acid transfer pump cubicle AHUs in MAB

   f. Essential chiller area AHUs in MAB

   g. Chemical and Volume Control System (CVCS) valve cubicles AHUs in MAB

   h. Radiation monitor room AHUs in MAB

   i. Spent fuel pool (SFP) pump cubicle AHUs in Fuel Handling Building (FHB)

   j. Containment sump isolation valve cubicle AHUs in FHB

   k. ESF pump cubicles AHUs in FHB

9.4.1.2.1 Description:

1. Control Room Envelope HVAC System is safety-related and consists of three 50-percent-capacity redundant equipment trains except for the toilet/kitchen exhaust, heating, and computer room HVAC Subsystem which are nonsafety-related. The system is shown on Figure 9.4.1-2. The following is a description of the components and their function.

   a. Main Air Handling Unit

      Each of the three units consists of:

      1) Prefilters

         The prefilters are provided to protect the high-efficiency filters located downstream from coarse particles carried by the airstream. These filters have a 30 percent efficiency, based on the ASHRAE Standard 52 efficiency test.

      2) High-Efficiency Filters

         The high-efficiency filters used downstream of the prefilters are provided to supply clean air to the CR envelope. These filters have a 95 percent efficiency based on the ASHRAE Standard 52 efficiency test.

      3) Cooling Coils

Finned-tube coils cool supply air to the required cooling temperature. Drain troughs are provided to collect and remove condensate. The coil is cooled by chilled water from the Essential Chilled Water System. The cooling coils are designed for adequate heat removal capacity to maintain the area at the design ambient temperatures.

4) Supply Fan

The supply fans are centrifugal type with direct-drive, single-speed motors. Fan motors are totally enclosed, fan- cooled, and statically and dynamically balanced.

Redundant leaktight isolation dampers are provided in the outside air ductwork to each AHU. During emergency operation (initiated by the SI and loss of offsite power (LOOP) signal, outside air high radiation or smoke signal) these isolation dampers are closed automatically. In case of outside air high radiation or an SI signal, makeup air is provided automatically via the makeup and cleanup filter units. Each AHU is designed to supply the CR envelope areas with a continuous source of conditioned and filtered air.

b. Return Air Fan

The return air fans draw air from the required rooms via the return air ducts and then deliver it to the corresponding main AHU. The return air is mixed with the makeup air to form the total air flow through the main AHU. During smoke purge these fans exhaust the return air to the outside with l00 percent supply air makeup to the main AHU. The return fans are vaneaxial type with direct-drive, single-speed motors. Fan motors are totally enclosed, air-cooled, and statically and dynamically balanced.

c. Makeup Air Filter Unit

Each of the three units consists of the following:

1) Electric Heater

An electric heater is provided to reduce the moisture in the airstream to 70 percent relative humidity in order to protect and maintain the efficiency of the carbon filters. However, since the carbon filters in the makeup filter units are not credited in the Chapter 15 radiological accident analyses, operation of the heaters is optional. Operation of the heaters is not needed to maintain the relative humidity in the cleanup filter units below 70%, even assuming the pressurization air is at 100% RH.

2) Prefilters

The prefilters are provided to increase the life of the HEPA filters. The prefilters are designed for 85 percent efficiency based on the ASHRAE Standard 52 efficiency test.

3) HEPA Filters

HEPA filters are provided to remove radioactive particles from the airstream. HEPA filters are designed to meet performance requirements in accordance with the "Standards for HEPA Filters" issued by the Institute of Environmental Sciences (IES) (formerly American Association for Contamination Control [AACC]), CS-1-1968. The makeup air HEPA filters are not credited in the Chapter 15 radiological accident analyses.

4) Carbon Filters

The carbon filters are used to adsorb airborne radioiodine from the airstream. The makeup air carbon filters are not credited in the Chapter 15 radiological accident analyses.

5) HEPA Filters

A bank of HEPA filters is also provided downstream of the carbon filters to prevent carryover of charcoal particles from the carbon filters into the airstream.

6) Centrifugal Fan

Makeup air unit fans are direct-drive, centrifugal type with single-speed motors. Fan motors are totally enclosed, fan-cooled, and statically and dynamically balanced.

Normally, makeup air which is required to pressurize the CR envelope areas and provide a source of fresh air is supplied by the main AHU supply fan. During emergency operation (initiated by an SI or outside air high radiation signal) the makeup unit is used to filter outside air for makeup. However, the makeup filters are not credited in the Chapter 15 radiological accident analyses. The makeup unit fan delivers filtered air to the cleanup unit.

Makeup air to the makeup units is drawn from a common plenum where outside air is introduced through one of two physically separated air intakes. Only one intake (located in the EAB) is used for makeup air during an emergency. The other intake, which also serves the MAB, is used for 100 percent outside air during smoke purge. The emergency air intake is located on the east side of the EAB at El. 80 ft. The air intakes are designed to withstand the effect of missiles and tornadoes.

d. Control Room Air Cleanup Filter Unit

Each of the three units consists of the following:

1) Prefilters

The prefilters are provided to increase the life of the HEPA filters. The prefilters are designed for 85 percent efficiency based on the ASHRAE Standard 52 efficiency test.

2) HEPA Filters

HEPA filters are provided to remove radioactive particles from the airstream. HEPA filters are designed to meet performance requirements in accordance with the IES Standard CS-1-1968. These filters are not credited in the fuel handling accidents in Chapter 15.

3) Carbon Filters

The carbon filters are used to adsorb airborne radioiodine from the airstream. These filters are not credited in the fuel handling accidents in Chapter 15.

4) HEPA Filters

A bank of HEPA filters is provided downstream of the carbon filters to prevent carryover of charcoal particles from the carbon filters into the airstream.

5) Centrifugal Fan

Cleanup unit fans are direct-drive, centrifugal type with single-speed motors. Fan motors are totally enclosed, fan- cooled, and statically and dynamically balanced.

During emergency conditions (SI or high radiation signal) the cleanup air filter units are utilized to filter both outside air from the makeup filter units and part of the return air from the CR envelope. These filters are not credited in the fuel handling accidents in Chapter 15. The cleanup units also operate during LOOP, although there is no outside air supply from the makeup filter units. The filtered air from the cleanup units is supplied to the main AHUs.

Air flow through the cleanup filters is maintained below 70% relative humidity to ensure the assumed filter efficiencies for iodine removal used in the postulated Chapter 15 accidents (see Appendix l5D). The humidity is maintained by the cooling provided by the Essential Chilled Water System supply to the main CRE AHUs. Operation of the heaters in the CRE HVAC Makeup filters is not necessary to maintain the proper humidity over the charcoal beds, even assuming the pressurization air is at 100% RH.

e. Ductwork and Duct Reheat Coils

The ductwork and duct reheat coils are common to the three equipment trains. Reheat coils are provided in the supply ducts to areas served to control temperature during normal operation, temper outside air supply during smoke purge in winter (common for CR envelope and EAB main area), and provide heating during plant shutdown in winter. The reheat coils are electric type with temperature controls located in the areas served. The reheat coils are nonsafety-related and tripped by an isolated SI signal during an emergency condition to prevent inadvertent operation and possible degradation of safety cooling function.

f. Exhaust Air Fan

A single exhaust fan is provided to exhaust air from toilets and kitchen. The fan is an inline centrifugal type with a belt-drive, single-speed, open drip-proof motor.

The exhaust system operates only during normal operation and has no safety function. Two leaktight isolation dampers are provided in the exhaust duct and automatically closes during the CR envelope emergency mode.

g. Computer Room Air Handling Units

The computer room is pressurized by air supplied from the CR envelope main AHU. Heating and cooling is provided by separate nonsafety-related AHUs located in the room.

Two 100-percent-capacity AHUs are provided to condition and recirculate room air. Each AHU consists of the following:

1) Filters

These filters are provided to maintain a dirt-free room environment. They are 65 percent efficient, based on ASHRAE Standard 52.

2) Cooling Coil

Finned-tube coils cool supply air to the design temperature. Drain troughs are provided to collect and remove condensate. The coil is served by the TSC chilled water system which is described in Section 9.4.l.2.1, Item 3. The cooling coil is designed with adequate heat removal capacity to maintain the room at the design ambient temperature.

3) Electric Heating Coils

An electric heating coil provides heating during winter shutdown conditions.

4) Humidifier

An electric type humidifier is provided to prevent relative humidity from dropping below 40 percent.

5) Circulating Fan

A centrifugal fan is provided to supply and return conditioned room air.

The computer room AHUs are nonsafety-related and are served by a reliable source of power backed up by the TSC DG power.

2. <u>EAB Main Area HVAC System</u> is safety-related except for the heating system (other than ESF battery room heating coils), elevator machine room HVAC system, and electrical penetration area normal HVAC system. It consists of three 50-percent-capacity equipment

trains. Two of three EAB equipment trains (supply and return fans) are required to function for design basis accident conditions. The system is shown on Figure 9.4.1-1. The following is a description of the EAB Main Area HVAC System components and their function.

a. Main Air Handling Unit

Each AHU is designed to supply the EAB main areas with a continuous source of conditioned and filtered air, and consists of the following:

1) Prefilters, high-efficiency filters, and cooling coils are provided as described for the CR envelope main AHUs. Refer to Table 9.4-2.1 for performance data.

2) Supply Fans

The supply fans are vaneaxial type with direct-drive, single-speed motors. Fan motors are totally enclosed, air-cooled, and statically and dynamically balanced.

3) Electric Heating Coils

Electric heating coils are provided (in two of the three trains) - to temper the supply air during winter operation and during smoke purge. The heating coils are nonsafety-related and are tripped by an isolated SI signal to prevent inadvertent operation and possible degradation of safety cooling function during emergency conditions. CN-3119

b. Return Air Fans

During DBA conditions the return air fans draw air from the required rooms via the return air ducts and then deliver it to the corresponding main AHU. The return air is mixed with the makeup air to form the total air flow through the main AHU. During smoke purge these fans exhaust the return air to outside with 100 percent supply air makeup to the main AHU. The return fans are vaneaxial type with direct-drive, single-speed motors. Fan motors are totally enclosed, air-cooled, and statically and dynamically balanced.

c. Exhaust Air Fans

Exhaust fans are provided to exhaust air from the battery rooms. They are vaneaxial type with direct-drive, single-speed, spark-proof, totally enclosed motors.

During all modes of operation the battery rooms are exhausted to the outdoors with an air change rate sufficient to maintain a hydrogen concentration level below 2 percent by volume.

d. Ductwork and Duct Reheat Coils

The ductwork and duct reheat coils are common to the three equipment trains. The reheat coils are provided for the occupied areas to maintain room temperature within comfort limits during normal operation. Reheat coils are also provided for battery rooms to maintain room temperature suitable for the battery operation during normal and emergency operations. The reheat coils are of the electric type with temperature controls located in the areas being served. The reheat coils are nonsafety-related except those for the ESF battery rooms which are safety-related. The nonsafety-related reheat coils are tripped during emergency condition by an isolated SI signal to prevent inadvertent operation and possible degradation of safety cooling function.

e. Electrical Penetration Area HVAC Subsystem consists of the following:

1) Ventilation System

The electrical penetration areas are supplied with ventilation air from the MAB main supply system. The air is exhausted to the outside by two l00 percent exhaust fans. The supply and exhaust systems are nonsafety-related and serve no safety function. The exhaust fans are of the centrifugal type with direct-drive, single-speed, and have totally enclosed motors.

2) Air Handling Units

Two AHUs, one safety-related and the other nonsafety-related, are located in each train-related electrical penetration area to recirculate room air and provide cooling during emergency and normal conditions, respectively. Each AHU consists of a fin tube chilled water cooling coil and circulating fan (centrifugal type).

f. Chilled Water System

The EAB Main Area HVAC System, except for nonsafety-related AHUs in electrical penetration areas, is served by the Essential Chilled Water System (Section 9.4.1.2, Item 4). The nonsafety-related AHUs are served by the TSC Chilled Water System.

3. <u>Technical Support Center HVAC System</u> is nonsafety-related but complies with the habitability requirements of GDC 19. The system consists of one l00 percent equipment train except for supply and return fans, computer room AHUs, and chilled water system which have l00 percent redundancy. The system is shown on Figure 9.4.1-3. The following is a description of system components and their functions:

a. Main Air Handling Unit:

1) Prefilters, High-Efficiency Filters, and Cooling Coils

Same as for the CR Envelope HVAC supply unit, except the cooling coil is served by a separate nonsafety-related TSC Chilled Water System described below.

2) Supply Fan

Two 100-percent-capacity fans are provided. The supply fans are of the centrifugal type with direct-drive, single-speed motors. Fan motors are totally enclosed, fan-cooled, and statically and dynamically balanced.

3) Electric Heating Coil

An electric heating coil is provided to temper the supply air in winter during smoke purge or plant shutdown.

An isolation damper is provided to shut off the normal outside air makeup to the main AHU on detection of high radiation, or smoke at the outside air intake.

b. Computer Room Air Handling Units

The TSC computer room is pressurized by air supplied from the TSC main AHU. Heating and cooling is provided by separate nonsafety-related AHUs located in the room. Two l00 percent capacity AHUs are provided to condition and circulate room air. These units are the same as those for the CR computer room (Section 9.4.l.2.l, Item 1.g).

c. Return Air Fans

Two l00 percent return fans are provided to return the room air to the main AHUs during normal operation and exhaust to the outside during smoke purge operations. The return fans are centrifugal type with direct-drive, single-speed, and a totally enclosed motor.

d. Makeup Air Filter Unit

The makeup air filter unit consists of the same components as CR Envelope Makeup units.

Normally, makeup air is supplied by the supply AHU. Upon detection of high airborne radiation at the outside air intake, the makeup filter unit is utilized to filter the outside air makeup and part of the return air. However, filtration of makeup air is not credited in the Chapter 15 radiological accident analyses. The makeup unit fan delivers makeup air to the supply AHU.

e. Exhaust Air Fan

An exhaust fan is provided to exhaust air from the toilets and break room during normal operation. During the isolation mode (high radiation, or smoke at the outside air intake) the exhaust fan is shut down and the isolation damper closes.

The fan is of the centrifugal type, with a direct-drive, single- speed, totally enclosed motor.

f. TSC Chilled Water Subsystem

The TSC Chilled Water Subsystem supplies chilled water to the TSC AHU cooling coil as well as cooling coils for the main computer room, TSC computer room, electrical penetration area (normal only), FHB Post-Accident Sampling System (PASS) area, and MAB radwaste counting room.

This subsystem is shown on Figure 9.4.l-5 and consists of two 100-percent-capacity equipment trains with common piping as follows:

1) Water Chiller

   The two water chillers are the air-cooled condenser type and are provided with all necessary accessories for automatic operation. The chiller cools the chilled water to the design temperature listed in Table 9.4-2.l.

2) Chilled Water Pump

   The two chilled water pumps are of the centrifugal type and are used to circulate chilled water through the cooling coils.

3) Expansion Tank

   The expansion tank is common to the two trains and is provided to allow expansion due to temperature variations in the chilled water system.

4) Deleted

5) An air separator is utilized to remove air from the system. Air released by the air separator is channeled into the expansion tank.

6) Chilled Water Piping and Valves

   The chilled water piping is common to the two trains and is provided with necessary valves for isolating and regulating the chilled water flow.

The above TSC HVAC System components are nonsafety-related. With the exception of the exhaust fan, duct heat coils, and AHU heating coils, all components are served by a non-Class lE reliable power source backed up by the TSC DG.

4. <u>Essential Chilled Water System</u> is provided to supply chilled water to the chilled water cooling coils in the AHUs given in Section 9.4.1.2, Item 4.

   The system is shown on Figure 9.4.l-4 and consists of three 50 percent capacity equipment trains. Each train is composed of:

   a. Water Chillers

      There is one 300 ton water chiller in each train. Each of the water chillers is of the centrifugal type with a water-cooled condenser and is provided with necessary accessories for automatic operation. The chillers cool the chilled water to the design temperature listed in Table 9.4-2.1.

With the onset of cool weather and colder ECP temperatures, procedural requirements are invoked to adjust condenser cooling water flow to assure that condenser pressure:

1) stays above evaporator pressure for the range of normal and post-accident loads

2) stays below maximum desired pressure for the range of normal and post-accident loads.

b. Chilled Water Pump

The chilled water pump is a centrifugal type and is used to circulate chilled water through the cooling coils.

c. Expansion Tank

The expansion tank is provided to allow normal expansion due to temperature variation in the chilled water system.

d. Chilled Water Piping and Valves

The chilled water piping is provided with necessary valves for isolating and regulating the chilled water flow.

9.4.1.2.2 Instrumentation Application:

1. Control Room Envelope HVAC System:

All fans are operable from the main CR. Temperature control is provided inside the CR envelope to control space temperatures by controlling reheat coils. Indication of the amount of filter loading for filters associated with the air handlers is provided locally for each of the air handlers. In addition, a pressure differential recorder is provided in the main CR for the upstream HEPA filters associated with both the cleanup and the makeup units.

The following instrumentation is provided in addition to that shown on Figure 9.4.1-2.

- Alarms for CR fan trouble
- Position indication for isolation dampers
- Indication for the operational status of the fans

2. EAB Main Area HVAC System:

Fans are operable from the main CR and the transfer switch panel in the ESF switchgear room, with the exception of the elevator machine room exhaust fan.

Room temperatures are controlled by temperature controls located in the various rooms of the EAB. Indication of the amount of filter loading for particulate filters associated with the EAB AHUs is provided at each of the AHUs.

The following instrumentation is provided in addition to that shown on Figure 9.4.1-1.

- Position indication for dampers
- Indication for the operational status of the fans
- Alarm for fan trouble

3. TSC HVAC System:

The fans are operable from the TSC local panel. The indication of the amount of filter loading for the AHU and makeup air filter unit is provided locally.

The following information is provided at the TSC local panel in addition to that shown on Figure 9.4.1-3.

- Position indication for dampers
- Indication for the operational status of the fans

4. Essential Chilled Water System:

The water chillers and the chilled water pumps are operable at auxiliary shutdown stations and from the main CR.

Each chiller is provided with all necessary accessories for automatic operation. A local panel is provided with each chiller to monitor and control the water chiller. This monitoring includes indications of temperature and pressure.

All chilled water system trains (three) are placed in operation automatically upon receipt of an SI signal or a LOOP. Bypass flow around the cooling coils is isolated upon receipt of an SI signal. The status of the affected equipment is not changed when the actuation signal is reset.

The following instrumentation is provided in addition to that shown on Figure 9.4.1-4.

- Pump status lights
- Chiller status
- Pumps status on computer
- Chiller trouble alarms
- Valves position indicating lights on main control board

9.4.1.3 Safety Evaluation. Continued operation of the safety-related portion of the CR Envelope HVAC System and EAB Main Area HVAC system during all modes of operation is ensured by the following design features in addition to the general features described in Section 9.4.1.1.

1. Design of system components, except the smoke detectors, meets seismic Category I requirements.

2. During LOOP, active components such as motors, damper operators, controls, and instrumentation with safety functions (except outside air and smoke detectors) are served by their respective independent ESF power train. The pneumatic dampers are designed to fail in the safe position (as shown on Figures 9.4.1-1 through 9.4.1-5) during a LOOP. The smoke detectors are served by UPS.

   Following a LOOP, the CR envelope HVAC equipment operates in the filtered recirculation mode. No makeup air is supplied. In this way, should smoke be present at the outside air intake, no change in system operation would be required.

3. Redundancy of components ensures that the system meets the single active failure criterion. The system failure modes and effects analysis (FMEA) is presented in Table 9.4-5.l.

4. The system is adequate to meet the CR envelope habitability requirements as discussed in Section 6.4.

5. The system conforms to GDC l9 as it provides adequate radiation protection to permit occupancy of the CR envelope during or following postulated accident conditions, without the personnel receiving radiation exposures in excess of 5 rem TEDE (see Section 6.4 for CR Habitability System).

   The makeup air filter unit and CR air cleanup filter unit are capable of removing airborne radioactive iodine from the incoming air and the CR air and limiting it to acceptable levels. However, filtration of makeup air is not credited in the Chapter 15 radiological analyses. In addition, air cleanup filtration is not credited in the Fuel Handling Accident analyses. A detailed description of the radioactivity filtration capability of these filter unit is provided in Section 6.5.l.

   Detection of radioactivity in the CR ventilation inlet is provided by radiation monitors, as described in Section ll.5. Upon detection of high airborne radioactivity at the outside air intake, the makeup air is filtered by means of carbon filter units. However, filtration of makeup air is not credited in the Chapter 15 radiological analyses. A portion of the recirculation air is also filtered.

6. The CR envelope is maintained at a minimum of 0.125 in. wg positive pressure relative to the surrounding area following receipt of an outside air high radiation or SI signal with a maximum makeup air design value of 2,000 ft^3/min. The penetrations into the CR envelope are sealed or gasketed.

7. Two redundant radiation monitors are provided to monitor the makeup air; upon high radiation, they alarm and automatically place the makeup units and CR cleanup filter units into operation in order to meet GDC 19.

8. In the event of a postulated fire causing smoke in areas confined within the CR envelope boundary EAB Main Area, redundant smoke detectors located within the common return duct

will alarm in the CR upon detection of smoke. The operator may then place the appropriate system into the smoke purge mode of operation (i.e., 100 percent outside air) to purge the smoke from the inside the building as necessary. The return air carrying smoke is exhausted outside by the return air fans by way of isolation and relief dampers. However, this is only a secondary means of smoke purge. The primary means of smoke purge is by portable fans as described in the Fire Hazard Analysis Report (FHAR).

In the event of smoke reaching the outside air intake, two redundant smoke detectors are provided in the common outside makeup air duct. The smoke detectors are located near the junction between the two air intakes and the common duct to minimize transit time of smoke to the detectors. The smoke detectors alarm the condition in the CR and automatically isolate the CR by closing the redundant outside air isolation dampers.

The HVAC equipment areas and the rooms in the CR envelope and EAB are separated by fire walls. Ductwork from equipment areas to the CR, computer room, relay room, and switchgear room are protected by fire dampers. Fire in any area is isolated by fire walls and fire dampers.

9. The Essential Chilled Water System, including the water chillers, chiller pumps, and chilled water piping and supports, is designed to meet the seismic Category 1 requirements. No common piping is provided in the Essential Chilled Water System with the exception of some piping runs in several rooms in the EAB, FHB and MAB each train is completely isolated from the other train. The system conforms to the codes and standards outlined in Section 3.2. CN-3178

10. The HVAC ductwork is designed to seismic Category I requirements and a normal operating pressure based on the fan shutoff pressure.

11. The failure of nonessential systems, structures, or components located close to essential portions of the system will not preclude operation of the CR envelope and the EAB Main Area HVAC System.

12. The system is located in a seismic Category I structure that is tornado-missile-, and flood-protected.

13. If a loss of offsite power event occurs coincident with extremely cold weather, operator action to place the third train of the Essential Chilled Water System in the standby mode is assumed to occur within 30 minutes so that the remaining two trains remain sufficiently loaded.

14. If one train of chilled water fails during a loss of offsite power event or initiation of safety injection event, the corresponding train of EAB HVAC should be stopped to preclude the addition of heat from non-cooled re-circulated air that may prevent sufficient cooling of vital equipment.

15. The Essential Chilled Water System provides cooling to the main CRE AHUs thereby maintaining the relative humidity of the air flow through the cleanup filters below 70%. This ensures the assumed filter efficiencies for iodine removal used in the postulated Chapter 15 accidents (see Appendix 15D).

9.4.1.4 Inspection and Testing Requirements. To assure and demonstrate the capability of the EAB HVAC System to perform the assigned function, tests are performed to verify proper wiring and control hookup, proper function of system components and control devices, and to perform final air balance of the system. A preoperational test is conducted with equipment and controls operational to verify that the system operation meets design requirements. To ensure a continued state of readiness of the EAB HVAC System after completion of the preoperational tests, RG l.52 and the Plant Technical Specifications, where applicable, will be followed in the performance of periodic inspection, maintenance, and testing. Table 9.4-4 describes the testing requirements for the HEPA and carbon filters.

9.4.2 Fuel Handling Building Heating, Ventilating, and Air Conditioning System

9.4.2.1 Design Basis. The FHB HVAC System is designed in accordance with the following:

1. The system is designed to:

   a. Provide continuous air flow across the water surface of the SFP and controlled ventilation air flow in other FHB spaces. Ventilation air flow is from areas of low to progressively higher radioactivity levels. The system is capable of maintaining a negative pressure in the FHB relative to the outside during normal operation and during accident conditions (except when the railway door is open).

   b. Provide ambient conditions in the FHB, as listed in Table 9.4-l, to ensure a suitable environment for personnel and equipment in the building. The system also purges the moisture and radioactive gases that evaporate from the spent fuel pool. During extremely cold weather, appropriate compensatory action, such as portable heaters may be used to temper air to prevent excessively low building temperatures during an emergency actuation. This action will be controlled by a station procedure. This will be done without modifying existing plant circuits.

   c. Mitigate the consequences of a fuel handling accident as well as a Loss-of-Coolant Accident (LOCA). This is accomplished by routing exhaust air from the spent fuel pool and the remainder of the FHB through ESF filter units containing HEPA filters and iodine removal carbon filters if high levels of airborne radioactivity are detected in the exhaust air (automatically upon an SI signal). This system is not credited in the Chapter 15 radiological analyses for the LOCA or the fuel handling accident.

   d. The system meets/complies with GDCs 2, 5, 60, and 61.

2. Equipment motors and controls in the safety class portions of the system are supplied with power from Class lE electric power sources and have sufficient redundancy to satisfy the single failure criterion.

3. The SC and seismic category of the system components are listed in Section 3.2.

4. System components and ductwork are protected against outside missiles and dynamic effects of tornado and wind pressure since they are located within a seismic Category I structure and protected by a tornado isolation damper at both the air intake and main exhaust vent.

9.4.2.2 System Description. The FHB HVAC consists of the following subsystems:

1. Supply Air Subsystem

2. Supplementary Coolers Subsystem

3. Exhaust Air Subsystem

The configuration of these subsystems is shown on Figures 9.4.2-l and 9.4.2-2, and design data of principal system components are listed in Table 9.4-2.2. Figures l.2-39 through l.2-46 show the location of systems, structures, and cubicles in the FHB.

The system serves the following safety-related areas within the FHB in addition to the various other areas.

l. Room containing SFP pumps and heat exchangers (HXs)

2. Rooms containing valves

3. Rooms containing HVAC equipment

4. Rooms containing high-head safety injection (HHSI) pumps, low-head safety injection (LHSI) pumps, and Containment spray pumps (Emergency Core Cooling System [ECCS]).

The ventilation subsystems listed above, and their functions during different modes of plant operation, are described as follows.

9.4.2.2.1 Supply Air Subsystem: The Supply Air Subsystem (Figure 9.4.2-1) provides the building with a filtered source of outside air at the proper temperature.
Air is supplied to various areas of the FHB by this subsystem before being picked up by the Exhaust Air Subsystem thus supplying complete ventilation of the building.

The Supply Air Subsystem has three 50 percent trains, (nominal flow of 13,615 cfm/train) each consisting of the following components:

1. Prefilters

   The prefilters are provided upstream of the heating coils. The prefilters are designed for 55 percent efficiency in accordance with ASHRAE Standard 52.

2. Electric Heating Coils

   Electric heating coils are provided downstream of the prefilters. Heating coils are designed for adequate heating capacity to temper the outside supply air to the design temperature.

3. Cooling Coils

   Finned-tube coils are located downstream of the electric heating coils. The coils utilize chilled water from the MAB Chilled Water Subsystem. The cooling coils are designed for adequate cooling capacity to maintain the building within the design ambient temperatures.

4. Supply Fans

The supply fans are of the vaneaxial type with direct-drive, single-speed motors. Fans have totally enclosed, air-cooled motors and are statically and dynamically balanced.

Upon LOOP or in case of a fuel handling accident, the Supply Air Subsystem is shut down. Emergency makeup air dampers are opened to permit outside air into the FHB by the effect of negative pressure maintained by the Exhaust Air Subsystem.

During normal plant operation, the supply air damper downstream of the supply fans is modulated to maintain a negative pressure in the building relative to the outside atmospheric pressure. The only exception is during rail cask car movement when the pressure differential controller is overridden and the modulating supply damper permits a preset minimum air quantity.

9.4.2.2.2 Supplementary Coolers Subsystem: This subsystem (Figure 9.4.2-1) is designed as safety-related and seismic Category I, except as noted below, and is used for removing heat from cubicles containing the following pumps and valves:

1. HHSI pumps (ECCS cubicles)

2. LHSI pumps (ECCS cubicles)

3. Containment spray pumps (ECCS cubicles)

4. SFP pumps

5. Containment sump isolation valves (Recirculation Valve Cubicle)

6. PASS area (nonsafety-related)

Coolers are provided to avoid using a large rate of ventilation air for removing heat dissipated by the large-size pump motors. The coolers are of the recirculating type and recirculate cubicle air.

Each supplementary cooler is located within or near the cubicle it serves. Each supplementary cooler consists of the following components:

1. Cooling Coil

Finned-tube cooling coils are located upstream of the circulating fan and utilize essential chilled water as cooling medium, with the exception of the PASS cooler. The PASS Supplementary Cooler cooling coil utilizes chilled water from TSC chilled water system.

2. Circulating Fans

Fans are propeller type with direct-drive, single-speed motors or centrifugal type with belt-drive. Fans have totally enclosed, air-cooled or fan-cooled motors and are statically and dynamically balanced.

The supplementary coolers are designed to remove the heat dissipated from the corresponding cubicle pump motors, valve motors, and associated piping to maintain the cubicles within the design temperature limits.

Ventilation air introduced into each of the cubicles is used to maintain a one-way flow of air from the general areas in the building to the ECCS pump cubicles and SFP pump and valve cubicles, which have a higher level of airborne radioactivity. Failure of air flow to any of these cubicles does not affect the operation of the coolers.

The PASS Cooler Circulating Fan is powered from a reliable power source (TSC diesel).

9.4.2.2.3 Exhaust Air Subsystem: The ventilation air supplied to the building is exhausted to the plant main vent stack through return air registers in the cubicles and exhaust ventilation ducts. The exhaust air subsystem also serves the PASS sampling panel and fume hood. The Exhaust Air Subsystem (Figure 9.4.2-2) air flow capacity is in excess of the Supply Air Subsystem air flow capacity to maintain the building under negative pressure. This subsystem is designed as safety-related and seismic Category I.

The Exhaust Air Subsystem consists of:

1. Filter Units

   There are two 100-percent-capacity redundant filter trains, each consisting of three filter units. Each filter unit has the following components.

   a. Electric Heating Coil

   Electric heating coils are provided to reduce the moisture in the air stream to a 70-percent-relative-humidity level, in order to protect the carbon filters from moisture.

   b. Prefilters

   The prefilters are used to increase the life of HEPA filters by collecting the coarse particles. The prefilters are designed for 85 percent efficiency in accordance with ASHRAE Standard 52.

   c. HEPA Filters

   HEPA filters are provided to remove radioactive particles from the building exhaust air in order to reduce releases and minimize site boundary dose. However, these filters are not credited in the Chapter 15 radiological analyses for the LOCA or the fuel handling accident. HEPA filters are designed to meet performance requirements in accordance with the "Standard for HEPA Filters" issued by the IES, CS-1-1968.

   Another set of HEPA filters is provided downstream of the carbon filters to prevent carryover of charcoal particles from the carbon filters into the exhaust air stream.

   d. Carbon Filters

Carbon filters are provided to remove radioactive iodine gases released of the Exhaust Air Subsystem. However, these filters are not credited in the Chapter 15 radiological analyses for the LOCA or the fuel handling accident.

The performance of carbon filters is in accordance with the NRC Reactor Development Technology (RDT) Division standard, "Gas-Phase Adsorbents for Trapping Radioactive Iodine and Iodine Compounds" RDT #Ml6-lT.

2. Main Exhaust Fans

Three 50-percent-capacity main exhaust fans of the centrifugal type are provided. The fans are of the direct-drive type with single-speed motors. Fan motors are totally enclosed, fan-cooled, and statically and dynamically balanced.

3. Exhaust Booster Fans

Three 50-percent-capacity exhaust booster fans of the vaneaxial type are provided. The fans are of the direct-drive type with single-speed motors. Fan motors are totally enclosed, air-cooled, and statically and dynamically balanced.

Normally, exhaust air bypasses the filter units and is exhausted directly to the plant main vent stack. Upon detection of high radiation or SI signal, exhaust air is routed through the filter units, the exhaust booster fans, and main exhaust air fans, and is then delivered to the plant main vent stack.

9.4.2.2.4 Instrumentation Application: The ESF actuation system for the FHB HVAC System is described in Section 7.3.3. Provisions have been made on the main control panel for control of the supply, main exhaust, exhaust booster fans, and supplementary cooler fans, except the PASS cooler. The supply fans can also be controlled from a local panel. Status indicating lights are provided in the CR for the system fans. Control switches and status indicating lights are furnished in the CR for the supply subsystem isolation dampers and exhaust filter train isolation dampers.

The supply fans are interlocked with the main exhaust fans so that an exhaust fan must be running before its train-related supply fan can start. Trip of an exhaust fan will result in the trip of its corresponding supply fan. All main exhaust fans and exhaust booster fans automatically start, and both l00 percent exhaust filter train isolation dampers open upon detection of a high radiation level in the exhaust air or an SI signal. The radiation level of the FHB exhaust air is continuously monitored by the Radiation Monitoring System (RMS). (See Section ll.5 for a discussion of the Process and Effluent Radiological Monitoring System.) The exhaust air bypass dampers automatically close upon high radiation or SI signal. This action assures that the exhaust air is routed through the carbon filter trains. During a LOOP, the supply air subsystem is shut down, the emergency makeup dampers are open, the bypass dampers remain open, and the exhaust fans are energized. A high radiation signal will override the LOOP. (See Section 6.5.l for a description of the FHB exhaust filter train instrumentation.)

A modulating volume of supply air is delivered to the FHB by an air flow control system which senses flow downstream of the supply fans and modulates the supply air damper to maintain a constant negative pressure in the building with respect to the outside. Supply air temperature is controlled by a temperature control system which modulates two-way chilled water valves on the

Supply Air Subsystem cooling coils. A separate temperature control system stages the heater control for the supply air subsystem electric heating coils.

Dampers located downstream of the ESF filter trains are controlled by manual loading stations located within the main CR to maintain a constant discharge air flow to compensate for filter loading. Once this air flow is established, the damper remains at the setpoint required.

Safety-related supplementary cooler fans start upon high temperature in the cubicle or upon manual start. Cooler fans for HHSI, LHSI, Containment Spray System (CSS) and spent fuel pumps start automatically when the pump starts. The supplementary coolers for recirculation valve cubicles start automatically when the corresponding pump cubicle cooler starts. The nonsafety-related PASS supplementary cooler starts when the setpoint of the high temperature switch is reached.

Local pressure differential switches are provided across the safety-related fans, except the supplementary cooler fans; local pressure differential indicators are provided across the system filters. Remote monitoring through the plant computer is provided for FHB differential pressure and exhaust air flow rate to the plant main exhaust duct.

Alarms are displayed to the operator in the CR for the following:

1. Automatic trip of any fan, except PASS cooler fan
2. High and high-high temperature of the carbon filters
3. High temperature in the cubicles served by the safety-related supplementary coolers
4. High radiation level in the exhaust air
5. High pressure differential across exhaust filter bank and supply air system filters
6. High/Low emergency exhaust air flow rate
7. High and low temperature of supply air
8. Low building negative pressure differential relative to the outside atmosphere

9.4.2.3 Safety Evaluation. Continued operation of the system essential components during all modes of operation is assured by the following features for which the system is designed.

1. The supplementary coolers serving the ECCS pumps, SFP cooling pumps, and valve cubicles are designed to meet seismic Category I requirements, as listed in Section 3.2.
2. During LOOP, all active components such as motors, damper operators, controls, and instrumentation (except the supply fans and associated damper operators) receive power from their respective independent ESF power train.
3. System components are protected against internally and externally generated missiles (by virtue of location within the building and equipment design) and are designed to withstand the effects of tornadoes, wind pressure, flood, and pipe whip. The cubicle coolers are located in rooms that will withstand the effects of both flooding and missiles.

4. Radiation monitors are provided for the FHB HVAC System exhaust which annunciate in the CR upon detection of high radiation level.

   Contaminated effluents released from the surface of the fuel pool become entrained in the ventilation air and are drawn into the exhaust air duct located in the SFP area. Radiation monitor sample points are located in the exhaust duct for the SFP as close as practicable to the SFP. High radiation or SI automatically diverts exhaust air through carbon filter units. Also, the same high-radiation or SI signal automatically starts the exhaust booster fans and opens the emergency makeup air dampers which shutdown the supply fans.

   No credit for FHB HVAC operation, or radiation monitors in the FHB, is taken for either the Chapter 15 LOCA or fuel handling accident analyses.

5. To meet the single active failure criterion, the following redundancies are provided:

   a. One 100-percent-capacity supplementary cooler for each ECCS cubicle, SFP pump, and valve cubicles

   b. Three 50-percent-capacity exhaust booster fans and main exhaust fans

   c. Two l00 percent exhaust carbon filter trains

   d. Two 100 percent emergency makeup air dampers

   e. Two exhaust air bypass line dampers in series

   The system FMEA is presented in Table 9.4-5.2.

   Three 50-percent-capacity supply fans are provided for reliable, continuous normal operation.

   Three 50-percent-capacity Supply Air Subsystem filters are provided to allow changing the loaded filters without interrupting the system operation.

6. The ventilation air purge rate maintains the concentration of radioactive gases in the FHB air below the maximum permissible concentration (MPC), as listed in l0CFR20 Appendix B prior to 1994.

7. The carbon filters in the exhaust subsystem are ESF filters, as discussed in Section 6.5.l. Filter efficiencies are listed in Tables 9.4-2.2 and 9.4-4. A comparison of the FHB exhaust system with RG l.52 is given in Table 6.5-l.

8. The FHB Exhaust Air Subsystem is designed to seismic Category I requirements.

9. The SFP area is maintained at negative pressure relative to the outside during normal operation (except during railroad car movement) and DBA, thereby minimizing any possibility of leakage of unacceptable, unfiltered, contaminated air to the outside.

10. Failure of nonessential portions of the system, or of other systems not designed to seismic Category I standards, will not preclude operation of the essential portions of the system.

9.4.2.4 Inspection and Testing Requirements. To ensure and demonstrate the capability of the FHB HVAC System, the system components and equipment are subjected to testing to verify proper wiring and control hookup, proper function of system components and control devices, and to perform final air balance of the system. A preoperational test is conducted with equipment and controls operational to verify that the system operation meets design requirements. To ensure a continued state of readiness of the FHB HVAC System after completion of the preoperational tests, RG l.52 (Table 6.5-1) and the Plant Technical Requirements Manual will be followed in the performance of periodic inspection, maintenance, and testing. Table 9.4-4 describes the testing requirements for the HEPA and carbon filters.

9.4.3 Mechanical Auxiliary Building Heating, Ventilating, and Air-Conditioning System

9.4.3.1 Design Bases. The MAB HVAC System serves the MAB and is designed in accordance with the following:

1. Maintain environmental temperatures within the design limits as listed in Table 9.4-l during normal plant operating conditions. The listed temperatures provide a suitable environment for personnel comfort in office and laboratory areas and also ensure operability of the equipment and controls located within the MAB.

2. Maintain environmental temperatures for nuclear safety-related equipment in cubicle areas listed in Table 9.4-l for abnormal plant operation. The listed temperatures are achieved by the use of Safety Class 3, seismic Category I supplementary cubicle coolers utilizing Essential Cooling Water (ECW), Component Cooling Water (CCW), or Essential Chilled Water as a cooling medium to ensure operability of the equipment.

3. Maintain the main building areas under a negative pressure during normal operation relative to the outside atmosphere in order to prevent any unmonitored leakage of potentially contaminated air from the building to the environment.

4. Maintain air flow within the building from areas of lower radioactivity to areas of higher potential radioactivity.

5. Provide adequate exhaust air filtration from sample room and radiochemical laboratory.

6. Provide the building with a continuous source of fresh air to continuously purge the inside atmosphere and limit the concentration of airborne radioactivity below the MPC listed in l0CFR20, Appendix B prior to 1994 (Section 12.2).

7. Limit releases of radioactive materials to the site boundary and assure that the released activity concentrations are within MPC specified in l0CFR20, Appendix B prior to 1994 and are as low as is reasonably achievable (ALARA) in accordance with 10CFR50, Appendix I.

8. Where needed, provide structurally sound ductwork to withstand the effects of a high energy line break.

ORNL Publication ERDA 76-2l, "Design, Construction and Testing of High-Efficiency Air Cleaning Systems for Nuclear Application" and RG 1.140 are used as guides in the detailed design of the MAB HVAC System. Classification of components is listed in Section 3.2. A general layout of the MAB can be found in the general arrangement drawings listed as Figures 1.2-26 through 1.2-30 in Table 1.2-1.

9.4.3.2 System Description. The MAB HVAC System consists of the following subsystems:

1. Main Supply and Exhaust System serving cubicles and main areas in the MAB
2. Supplementary Cubicle Coolers Subsystem serving equipment located in MAB
3. Supplementary Supply and Exhaust Subsystem serving locker rooms, miscellaneous offices, and laboratories
4. MAB Chilled Water System providing chilled water to Main Supply and Supplementary Supply Systems
5. Essential Chilled Water System providing chilled water to Supplementary Cubicle Coolers

The MAB HVAC Subsystems are illustrated on Figures 9.4.3-1 through 9.4.3-6, and principal system component design data are listed in Table 9.4-2.3 and as described in this section.

9.4.3.2.1 Main Supply and Exhaust System: The Main Supply System (Figure 9.4.3-1) consists of four 25-percent-capacity built-up supply air casings, three 50-percent-capacity supply fans, and the necessary supply air control dampers and ductwork. Each casing consists of a prefilter bank, heater bank, cooling coil bank, and isolation dampers.

1. The following is a brief description of the various components that comprise each of the supply air casings and supply air distribution system:
    a. The prefilter is rated for 55 percent efficiency based on ASHRAE Standard 52.
    b. The electric heating coils located downstream of the prefilters are designed and controlled to temper the outside supply air to limit environmental air temperatures within the MAB to 50°F.
    c. Chilled water cooling coils are designed and controlled to temper outside supply air to limit the maximum environmental air temperature within the MAB to those temperatures listed in Table 9.4-l.
    d. Pneumatically operated fail-closed isolation dampers are located upstream of each filter bank and downstream of each cooling coil bank to isolate each casing for maintenance and to prevent cooling coil freeze-up upon loss of heating coils during winter operation.
    e. Supply fans are direct-drive centrifugal types with single speed, totally enclosed, fan-cooled motors.

f. A pneumatically operated, fail-closed isolation damper is provided at each supply fan outlet to preclude reverse rotation of fan wheel and short-circuiting of supply air when fan is placed on standby.

g. Each supply fan is interlocked with its associated exhaust fan to shut down when the exhaust fan trips to preclude positive pressure within the MAB.

h. A separate path for EAB makeup air is provided from the MAB intake through a CR-controlled damper.

The Main Exhaust System (Figure 9.4.3-4) consists of three 50-percent-exhaust fans, associated isolation dampers, ductwork, and isokinetic air sampling stations.

2. The following is a brief description of the components that comprise the Main Exhaust System:

   a. Exhaust fans are direct-driven vaneaxial types with totally enclosed, air-cooled motors.

   b. A pneumatically operated, fail-closed damper is provided at outlet of each fan to preclude reverse rotation of fan wheel and short circuiting of exhaust when fan is placed on standby.

   c. Isokinetic air sampling stations are placed in branch exhaust ducts that serve several cubicles which could possibly become a contamination source. The sampling stations, in conjunction with monitors, measure the particulate, iodine, and noble gas levels prior to being exhausted by the main exhaust fans and will alarm if the levels exceed the setpoint of the monitors.

9.4.3.2.2 Supplementary Cubicle Cooler Subsystem: The Supplementary Cooler Subsystem (Figure 9.4.3-3) consists of 21 draw-through fan-coil units; 19 units serve areas or cubicles with safety-class equipment and 2 units serve nonsafety-class areas (radwaste counting room, and positive displacement charging pump cubicle). The 19 units serving the safety-class equipment areas provide a controlled environmental temperature during normal or abnormal plant operation.

1. The main components of the cubicle coolers are:

   a. Finned-tube cooling coil which utilizes either ECW, CCW, Essential Chilled Water, or TSC chilled water as a cooling medium.

   b. Recirculating fans are direct-driven by single speed, totally enclosed, fan-cooled or air-cooled motors.

   c. The radwaste counting room cooler also includes a prefilter, HEPA filter, and electric heating coil.

2. The following listed cubicle areas are being served by cubicle coolers:

Area/Cubicle	Cooling Medium	ESF Train of Coolers
CCW Pump Cubicle A	ECW	A
CCW Pump Cubicle B	ECW	B
CCW Pump Cubicle C	ECW	C
Centrifugal Charging Pump Cubicle A	CCW	C
Centrifugal Charging Pump Cubicle B	CCW	A
Positive Displacement Charging Pump Cubicle lA	CCW	N/A
Valve Cubicle No. 044	Essential Chilled Water	C
Boric Acid Transfer Pump Room No. 018	Essential Chilled Water	A & C
Valve Cubicle No. 033	Essential Chilled Water	A & B
Reactor Water Makeup Pump Room No. 062	Essential Chilled Water	B & C
Valve Cubicle No. 226	Essential Chilled Water	B & C
Radiation Monitor Room No. 327A	Essential Chilled Water	A & C
Essential Chiller Area Room No. 067	Essential Chilled Water	A
Essential Chiller Area Room No. 067E	Essential Chilled Water	B
Essential Chiller Area Room No. 067F	Essential Chilled Water	C
Radwaste Counting Room No. 231	TSC Chilled Water	N/A

9.4.3.2.3 <u>Supplementary Supply and Exhaust Subsystem</u>: The Supplementary Supply Subsystem (Figure 9.4.3-1) is a single-zone reheat design consisting of an AHU, two l00-percent-capacity supply fans, duct-mounted heating coils, ductwork, and associated isolation dampers.

1. The main components of the AHU and supply air distribution system are as follows:

   a. High efficiency filter bank to filter the prefiltered outside air from the main MAB intake air plenum. The filter is rated for 90 percent efficiency based on ASHRAE Standard 52.

   b. The unit-mounted electric heating coil preheats entering outside air to provide freeze protection for cooling coils and temper outside air to 50°F.

   c. Finned-tube cooling coils, utilizing MAB chilled water as a cooling medium, are controlled to maintain a constant supply air temperature.

   d. Supply fans are vaneaxial type, direct-driven by single-speed, totally enclosed, air-cooled motors. One of the supply fans is placed on standby.

   e. Duct-mounted electric heating coils temper the supply air when required to maintain controlled room air temperatures for areas being served, as listed in Table 9.4-l.

   f. Pneumatically operated fail-close isolation dampers are mounted downstream of the supply fans to preclude reverse rotation of the standby fan and short-circuiting of supply air.

   g. The prefilters are 55 percent efficient and are located in the outside air intake.

The Supplementary Exhaust Subsystem (Figure 9.4.3-3) consists of two package filter units, two l00-percent-capacity exhaust fans, ductwork, and associated isolation dampers. One filter unit serves the sample room and the other serves the radiochemical laboratory. The filter units are provided to filter radioactive particulate and iodine gases from both laboratory and sample room hoods prior to being discharged to MAB Main Exhaust Subsystem.

1. The main components of each filter unit and exhaust subsystem are as follows:

   a. A prefilter bank rated at 85 percent efficiency is located upstream of the HEPA filters to protect the HEPA filters from coarse particulates.

   b. A HEPA filter bank is provided to capture radioactive particulate from the airstream.

   c. A carbon filter bank is provided to remove radioactive iodine gases from the airstream.

      The carbon filter performance is in accordance with the RDT standard No. M16-1T.

   d. A HEPA filter bank is provided to prevent carryover of charcoal particles from the carbon filter bank.

   e. Exhaust fans are centrifugal type, direct-driven with single-speed, totally enclosed, fan-cooled motors.

   f. Manually operated isolation dampers are provided for each filter unit to isolate the unit during filter changes and maintenance.

2. A modulating damper is used to control and maintain negative pressure in the radiochemistry lab and sample rooms with respect to the surrounding areas.

9.4.3.2.4. MAB Chilled Water Systems: The MAB Chilled Water System Figure 9.4.3-5 is a closed-loop system that consists of three in Unit 1 and four in Unit 2 one-third-capacity water chillers, four 33-l/3 percent chilled water recirculation pumps, an expansion tank, an air separator, a chemical addition tank, isolation valves, and piping. The normal loads on the chilled water system are 100% outside air HVAC systems and the number of chillers that are in operation is dependent upon outside air conditions and main reservoir temperatures. During cold weather, the MAB chilled water system is operated in accordance with cold weather and system operating procedures which establish equipment requirements based on ambient air temperatures. Additionally, the chilled water header temperature may be adjusted to minimize excessive starts/stops of chillers when operating below peak load. The MAB Chilled Water System is nonsafety-related and provides chilled water to serve the MAB Main Supply System, Supplementary Supply System, and the FHB HVAC Supply System (Section 9.4.2) and provides cooling water for the breathing air compressor aftercooler in the Breathing Air System. The Open-Loop Auxiliary Cooling Water System is utilized for the chiller condenser section and demineralized water is utilized as makeup for the chilled water loop.

1. Main components of this system consist of the following:

   a. Chillers are centrifugal-type with water-cooled condensers.

   b. Chilled water recirculation pumps are centrifugal-type, direct-driven with open dripproof motors.

   c. The expansion tank is pressurized with nitrogen to maintain chilled water system pressure to assure a complete fill of distribution piping.

   d. An air separator is provided to separate air which is released from the system.

9.4.3.2.5 Essential Chilled Water System: System description can be found in Section 9.4.l.

9.4.3.2.6 Instrumentation Application: All fans are operable from the main CR, except the Radwaste Counting room cooler which is operable from the local TSC control panel, and the elevator machine room fan which is locally operated. Thermostats are provided for supplementary coolers and duct heaters to control space temperatures. The indication of the amount of filter loading for the MAB supply system and supplementary exhaust system is provided locally. MAB supply air temperature is indicated in the main CR. Plant main exhaust flow is monitored by the Emergency Response Facility (ERF) computer.

The following instrumentation is provided in addition to that shown on Figures 9.4.3-1 through 9.4.3-6.

- Alarms for main and supplementary exhaust fan trip
- Alarm for miscellaneous fan trips
- Alarms for various supplementary cubicle cooler trip

- Alarm on MAB chiller trip
- Alarm on MAB chilled water pump trip
- Alarm for MAB carbon filter temperature high and high-high
- Alarm for MAB chilled water expansion tank level high/low
- Alarm for supplementary exhaust filter high differential pressure

9.4.3.3 Safety Evaluation: The supplementary cubicle coolers for safety equipment areas and the water systems that serve them are classified as nuclear safety-related and are designed to SC 3, seismic Category I. The remaining HVAC Systems that serve the MAB are classified nonsafety-related and nonseismic. Nonsafety-related equipment, ductwork, and chilled water piping that are located in proximity to safety-related equipment are supported seismically to withstand plant Safe Shutdown Earthquake (SSE) loads to preclude degradation of the nuclear safety-related equipment. All MAB HVAC supply and exhaust air penetrations through designated fire barriers are equipped with 3-hour-rated fire dampers.

The supplementary cubicle coolers serving redundant trains are located in physically separated rooms and are not subject to floods, missiles, or pipe whip.

The MAB HVAC System FMEA is presented in Table 9.4-5.3.

9.4.3.4 Inspection and Testing Requirements. To assure and demonstrate the capability of the MAB HVAC System, components are tested to verify proper wiring and control hookup, proper function of system components and control devices, and to perform final air balance of the system. A preoperational test is conducted with equipment and controls operational to verify that the system operation meets design requirements.

Maintenance is performed on a regularly scheduled basis to check and replace filters, provide lubrication, etc., in accordance with the requirements of the preventative maintenance program.

9.4.4 Turbine Generator Building Heating, Ventilating, and Air-Conditioning System

9.4.4.1 Design Bases. The Turbine Generator Building (TGB) HVAC System is designed to perform the following functions during normal plant operation:

1. Control the thermal environment inside the TGB within the design limits, as listed in Table 9.4-l, suitable for personnel and equipment.

2. Provide the TGB with a source of outside air to continuously purge the inside atmosphere from possible process line and steam line leaks.

3. Provide accessibility for adjustments, periodic inspections, and testing of the principal system components to assure continuous functional reliability.

4. Provide filtered ventilation air to the switchgear rooms.

5. Purge the battery room on a continuous basis to maintain the hydrogen concentration below 2 percent.

6. Provide cooling to the Cold Chemistry Lab, Battery Room, and Battery Charger Room, Excitation Room, and Operator's Station Room for proper equipment operation and personnel comfort.

9.4.4.2 System Description. The TGB HVAC System consists of the TGB ventilation subsystem and the TGB supplementary HVAC subsystem (Figures 9.4.4-1 and 9.4.4-3). Principal system components design data are listed in Table 9.4-2.4 and described in this section.

9.4.4.2.1 TGB Ventilation Subsystem: The main components of this subsystem include:

1. Fifteen vaneaxial type supply fans and eight propeller type fans with direct-drive, single-speed motors.

2. Two 100 percent vaneaxial type exhaust fans with direct-drive, single speed motors for high equipment heat load removal.

3. Outside air intake control dampers of parallel two-position type for the once-through fans.

4. Outside air intake control dampers of opposed blade modulating type for the fans permitting recirculation.

5. Outside air intakes with bird screens and louvers.

6. Manually operable air relief louvers along the east wall of the feedwater heater bay and the west wall of the TGB with the bird screens.

The ventilation subsystem provides the TGB with a source of outside air. During cold weather operation the supply fans are started sequentially by a step controller. When the outdoor temperature is low, the once-through fans are shut down and the supply fans with recirculation provision provide mixed air by modulating the intake and return air dampers. Transfer fans are provided to improve air mixing and air movement throughout the building. Air from the main area of the TGB is exhausted to the outside through the manually operable relief louvers. Special direct ventilation and exhaust is provided for high equipment heat load area. Unit heaters maintain a minimum design temperature during winter weather.

9.4.4.2.2 TGB Supplementary HVAC Subsystems: The supplementary HVAC subsystems include the following subsystems and their components:

1. Cold Chemistry Lab Area HVAC Subsystem

   a. One packaged air-conditioning unit consisting of compressors, air-cooled condenser, and a draw-through-type AHU with direct expansion cooling coil, and throw-away type filters

   b. Three electric duct reheating coils

c. Toilet exhaust fan

The subsystem recirculates cool air, reheated if required, to maintain the Cold Chemistry Lab area within the design temperature. The area is slightly pressurized to reduce infiltration of unfiltered air. The toilet exhaust fan maintains a slight negative pressure in the toilets and janitor closet.

2. Battery Room and Battery Charger Room HVAC

This subsystem consists of one AHU with direct expansion cooling coil, one air-cooled condenser (remote), two electric duct reheating coils and two 100 percent exhaust fans for the battery room. The system maintains the temperature within the design limits (Table 9.4-1). Air supplied to the battery storage room is exhausted to the outside with no recirculation. This is done in order to maintain the hydrogen concentration below 2 percent. The air supplied to the battery charging area is recirculated. The operation of the supply fan is maintained even when the condensing unit is not operating. The exhaust fans receive electrical power from the non-Class 1E emergency DG backup motor control center (MCC) for the operation during loss of normal power.

3. Emergency non-Class 1E Diesel Generator Room Ventilation Subsystem

This subsystem consists of one 100-percent-capacity ventilation fan, outside air intake and exhaust louvers, control dampers, and a unit heater. The ventilation fan is of the propeller type with direct-drive, single-speed, air-cooled motor.

During normal operation, when the DG is not running, the ventilation air is drawn from outside through the louver and the intake damper and is exhausted by the fan to the outside. The exhaust fan receives electrical power from the emergency DG backup motor MCC.

The air required for radiator cooling and combustion during DG operation is drawn from the outside through another set of outside air intake louvers and control dampers. It is then exhausted to the outside by a fan mounted on the DG shaft.

A unit heater provides heating during winter operation.

4. 13.8 kV Switchgear Room and Cable Vault Ventilation Subsystem

This subsystem consists of two 50-percent-capacity fans, outside air intake louvers with bird screens, control dampers, prefilter ductwork, and unit heaters.

The subsystem provides the switchgear room and cable vault with a source of outside filtered air during normal plant operation. The air is relieved through floor openings from the cable vault to the switchgear area and through wall openings to the TGB main area.

During winter and mild weather, the outside air is mixed with the switchgear room return air before it is supplied to the areas to maintain the space design temperature.

The fans receive electrical power from the non-Class 1E emergency DG backup MCC for operation during loss of normal power.

During winter, the unit heaters maintain a minimum design temperature.

5. 4.16 kV Switchgear Room Ventilation Subsystem

   This subsystem consists of two 50-percent-capacity fans, outside intake louvers with bird screens, control dampers, ductwork, and unit heaters.

   The subsystem provides the switchgear room with a source of outside filtered air during normal plant operation. The air is relieved through wall openings to the TGB main area.

   The subsystem has provision to recirculate the room air when required.

   The fans receive electrical power from the non-Class 1E emergency DG backup MCC for operation during loss of normal power.

   The unit heaters maintain a minimum design temperature during winter weather.

6. Elevator Machine Room Ventilation Subsystem

   This subsystem consists of one 100-percent-capacity fan, outside air intake louver with bird screen, control damper, and a unit heater.

   The subsystem provides ventilation air to the elevator machine room by introducing the outside air.

   The unit heater provides heating during winter operation when the ventilation subsystem is shutdown.

   This subsystem is typical for the two elevator machine rooms.

7. Excitation Room HVAC Subsystem

   This subsystem consists of two window-type packaged air-conditioning units. The subsystem maintains the Excitation Room temperature below the maximum design limit.

8. Operator's Station Room HVAC Subsystem

   This subsystem consists of one 100 percent packaged air- conditioning unit. The subsystem maintains the operator's room below the maximum design temperature limit. The toilet area is exhausted by a fan with makeup from the TGB main area.

9. Electro-Hydraulic Cabinet Enclosure HVAC Subsystem

   This subsystem consists of two 100 percent window-type packaged air- conditioning units with a shared power supply. One unit is an installed spare. This subsystem maintains the electro-hydraulic cabinet enclosure temperature below the maximum design limit.

9.4.4.2.3 Instrumentation and Control: Local controls are provided for operation of the fans and air-conditioning units in the TGB. Strategically located individual temperature switches, or dedicated step controllers actuated by temperature control signals in the TGB Ventilation Subsystem, operate the respective fan discharge dampers. Damper limit switches operate the supply fans. Supply fans with provision for recirculation are operated automatically by the temperature switches.

Outside air intake and return air dampers associated with these fans modulate on a temperature control signal to provide the desired mixed air temperature.

The exhaust fan for high equipment heat load (condensate pumps) is started and stopped manually and failure of the fan starts the redundant fan automatically.

Transfer fans operate continuously to avoid stratification in the TGB main area.

Temperature controls in switchgear rooms automatically start the ventilation fans. When the fans are running, a temperature controller modulates the dampers.

Window and roof-top-type air-conditioning units in other areas operate automatically to maintain the designed room temperature.

Local alarms are provided for high temperature in the various rooms and areas and for low flow condition on the battery room exhaust fans. A common trouble alarm for the TGB is annunciated in a remotely located panel.

The electric unit heaters are operated by remote-mounted thermostats.

9.4.4.3 Safety Evaluation. The TGB HVAC System is nonsafety-related and nonseismic. Failure of the system does not result in conditions affecting safe operation of the plant. In the event of LOOP, the system shuts down.

9.4.4.4 Inspection and Testing Requirements. The TGB HVAC System is subjected to testing to verify proper wiring and functioning of system components and control devices. These tests are performed to balance design air flows and system operating pressures. Maintenance is performed on a regularly scheduled basis to check and replace filters, provide lubrication, etc., in accordance with the requirements of the equipment manufacturer.

9.4.5 Reactor Containment Building Heating, Ventilating, and Air-Conditioning System:

9.4.5.1 Design Bases. The Reactor Containment Building (RCB) HVAC System is designed to perform the following functions during normal and accident conditions.

9.4.5.1.1 Normal Operation:

1. Maintain environmental temperatures within the design limits as listed in Table 9.4-l. The listed temperatures provide a suitable environment to ensure proper operation of equipment and controls located within the RCB.

2. Maintain the containment atmospheric pressure between the design limits as listed in Table 3.ll-l.

3. Reduce the airborne radioactivity levels in the RCB atmosphere prior to personnel access during normal plant operation and after a reactor shutdown.

4. Purge the tendon gallery tunnel.

5. Limit the normal radiation release from the RCB within the guidelines specified in l0CFR20 prior to 1994.

9.4.5.1.2 Accident Conditions: The safety-related and seismic Category I portions of the RCB HVAC system are capable of meeting the following design bases assuming a single active failure of any component.

1. Cool the Containment atmosphere to reduce the adverse effect of a LOCA by reducing the temperature and pressure within the RCB. (The post-LOCA heat removal function is shared by the RCB HVAC System and the CSS; reference Section 6.2.2).

2. Limit the radiation released from the RCB within the guidelines specified in l0CFR50.67.

As a nonsafety-related backup system, the RCB HVAC system dilutes the Containment atmosphere with outside air and then exhausts approximately the same quantity of Containment air to the outside.

9.4.5.1.3 System Redundancy and Engineered Safety Features Power Supply: The safety-related components are designed to meet the single active failure criterion. Adequate redundant trains powered from independent ESF busses are provided. For the degree of redundancy and ESF power supply, see Table 9.4-l.

9.4.5.1.4 Seismic Design Requirements: The safety-related components are designed to seismic Category I requirements. Refer to Section 3.2 for classification of components.

9.4.5.2 System Description. The RCB HVAC System consists of the following subsystems:

1. Reactor Containment Fan Coolers (RCFCs) Subsystem

2. Containment Cubicles Exhaust Subsystem

3. Containment Carbon Units Subsystem

4. Control Rod Drive Mechanism (CRDM) Ventilation Subsystem

5. Reactor Cavity and Support Ventilation Subsystem

6. Normal Containment Purge Subsystem

7. Supplementary Containment Purge Subsystem

8. Tendon Gallery Tunnel Ventilation Subsystem

9. Elevator Machine Room Ventilation Subsystem

10. RCB Chilled Water Subsystem

The basic flow diagrams of the subsystems are shown on Figures 9.4.5-l through 9.4.5-6, and principal system component design data are listed in Table 9.4-2.5 and described in this section. The

RCFC Subsystem flow diagram is shown on Figure 6.2.2-4. For a basic layout of the RCB refer to the general arrangement drawings listed as Figures 1.2-12 through 12.2-20 in Table 1.2-1.

9.4.5.2.1 Reactor Containment Fan Cooler (RCFC) Subsystem: Additional descriptions of the RCFC system are provided in Sec. 6.2.2.2.1. The RCFC subsystem, designed as safety-related and seismic Category I, operates during all modes of plant operating conditions to maintain the temperature inside the containment below the limits listed in Table 9.4-1. The RCFC subsystem consists of three trains each with two RCFC units. Five RCFC units are required to be operable during normal plant operating conditions. For a LOCA, main steam (MS) line or feedwater (FW) line break conditions, a minimum of three RCFC units in conjunction with the CSS are required to operate.

Each RCFC unit consists of discharge ductwork, cooling coil, fan and back draft damper. Four return air risers with two independent sections of ring duct are shared by this subsystem. The following is a brief description of the various components that comprise each RCFC unit.

1. Discharge Ductwork and Return Air Risers

   The RCFC supply air is discharged primarily inside the periphery of the secondary shield wall. The air flows around the reactor coolant pumps (RCPs), steam generators (SGs) etc., up to the return air risers located above the main operating floor.

2. Cooling Coil

   The RCFC cooling coils are of the finned-tube type designed with the maximum practicable tube and fin spacing to avoid water clogging of coils when operating in an accident environment. Drain troughs are provided to collect and remove the condensate.

   During normal plant operating conditions the main mode of heat transfer is sensible cooling. RCB chilled water (Section 9.4.5.2.10) is utilized as cooling media during normal plant operating conditions.

   During accident conditions (line breaks inside Containment) the main mode of heat transfer is latent cooling. The cooling media during accident conditions is CCW. During a LOOP, RCB chilled water is isolated automatically, the cooling media for the RCFCs is transferred to the CCWS remote-manually from the main CR within 30 minutes.

3. RCFC Fan

   Each RCFC fan is of the vaneaxial type, statically and dynamically balanced and of the nonoverloading type. Each fan is directly driven by a totally enclosed, single-speed, air-cooled motor.

   The motor is seismically and environmentally qualified in accordance with the qualification programs described in Sections 3.l0 and 3.ll.

   Fan motor space heaters are provided to maintain favorable conditions of temperature and humidity within the motor.

4. Backdraft Damper

The RCFC subsystem discharges air directly into the lowest elevation inside the secondary shield wall. Due to the limited vent areas, the lowest level pressurizes more rapidly following a LOCA than the upper Containment volume. To protect the RCFC fan and motor against reversed flow, as well as the ring duct and RCFC enclosure against pressurization following a LOCA, a backdraft damper is provided in the fan discharge ductwork. The backdraft damper is normally closed when the fan is not running. (See also Sec. 6.2.2.)

9.4.5.2.2 Containment Cubicles Exhaust Subsystem: The Containment Cubicles Exhaust Subsystem (Figure 6.2.2-4), designed as safety-related and seismic Category I, operates during all modes of plant operating conditions, except during a DBA, to maintain the temperature inside the following cubicles below the limits listed in Table 9.4-l.

1. Residual Heat Removal (RHR) Heat Exchanger (HX) Compartments
2. Excess Letdown HX Compartment
3. Regenerative HX Compartment
4. Valve Compartments
5. RHR Pump Compartments
6. Reactor Coolant Drain Tank (RCDT) Compartment
7. RCDT HX Compartment
8. RCDT Pump Compartment
9. Pressurizer Compartment
10. Radioactive Pipe Chase Area
11. Rod Position Indication Cabinet Compartment
12. Rapid Refueling Cable Tray Area

The Containment Cubicles Exhaust Subsystem consists of two 50 percent trains, each train consisting of two l00-percent-capacity fans. These fans are of the vaneaxial type, statically and dynamically balanced. Each fan is directly driven by a totally enclosed air-cooled motor. Cooler air from the Containment atmosphere is induced into the cubicles and discharged back to the Containment by the exhaust fans.

9.4.5.2.3 Containment Carbon Units Subsystem: The Containment Carbon Units' designed as nonsafety and nonseismic, operate only during normal plant operating conditions. These units operate to reduce the radioactivity levels in the Containment atmosphere prior to personnel access and before Containment purging.

The Containment Carbon Units Subsystem (Figure 9.4.5-6), consists of two 50-percent-capacity filter units each with two l00-percent-capacity fans. Each filter unit contains a prefilter, HEPA filter, charcoal adsorber, and post-HEPA filter. The following is a brief description of the various components that comprise each of the Containment Carbon Units.

1. Prefilter

   The prefilters are provided upstream of the HEPA filters to protect them from coarse particles and are designed for 85 percent efficiency in accordance with ASHRAE Standard 52.

2. HEPA Filter

   HEPA filters are provided to capture radioactive particulates from the airstream. The HEPA filters are designed in accordance with the requirements of American National Standards Institute (ANSI) N509-l976.

3. Charcoal Adsorbers

   The charcoal adsorbers are provided to remove the airborne radioiodine from the airstream.

4. HEPA Filter

   HEPA filters are provided downstream of the carbon filters to collect any carbon fines which may be carried into the airstream from carbon filters.

5. Circulating Fans

   The circulating fans are of the centrifugal type with direct-drive, single-speed motors. Fans have totally enclosed, fan-cooled motors, and are statically and dynamically balanced.

9.4.5.2.4 <u>Control Rod Drive Mechanism Ventilation Subsystem</u>: The CRDM Ventilation Subsystem (Figure 9.4.5-6), designed as nonsafety and nonseismic, operates during normal plant operating conditions and is capable of operating following a LOOP to maintain the CRDMs within their design ambient temperature. This subsystem consists of three 50-percent-capacity fans that induce cooler air from the Containment into the CRDM shroud and then discharge the air to the upper Containment atmosphere. The CRDM fans are of the centrifugal type with direct-drive, single-speed motors. Fans have totally enclosed, fan-cooled motors and are statically and dynamically balanced.

9.4.5.2.5 <u>Reactor Cavity and Support Ventilation Subsystem</u>: The Reactor Cavity and Support Ventilation Subsystem (Figure 9.4.5-6), designed as nonsafety and nonseismic, operates during normal plant operating conditions and is capable of operating following a LOOP. This subsystem removes the gamma decay and thermal heat from the reactor cavity wall to prevent dehydration of the concrete and cools the incore instrumentation cavities. This subsystem consists of two l00-percent-capacity supply fans and two l00-percent-capacity exhaust fans. The following is a brief description of the various components.

1. Supply Fans

The supply fans are of the centrifugal type with direct-drive, single-speed motors. Fans have totally enclosed, fan-cooled motors, and are statically and dynamically balanced.

2. Exhaust Fans

The exhaust fans are of the vaneaxial type with direct-drive, single- speed motors. Fans have totally enclosed, air-cooled motors, and are statically and dynamically balanced.

9.4.5.2.6 Normal Containment Purge Subsystem: The Normal Containment Purge Subsystem (Figure 9.4.5-2) operates during plant shutdown conditions. It is designed as nonsafety and nonseismic except the containment isolation valves and the radiation monitors which are safety-related and seismic Category I.

This subsystem is provided to reduce the concentration of gaseous and particulate contamination to assure safe continuous personnel access after shutdown. The frequency of use for the Normal Containment Purge Subsystem can be found in the Technical Specifications.

Normal Containment Purge Subsystem consists of one l00-percent-capacity AHU with two l00-percent-capacity supply fans and two l00-percent-capacity exhaust fans. The following is a brief description of the various components that comprise this subsystem.

1. Prefilter

The prefilters are provided upstream of the high efficiency filters to protect them from coarse particles and are designed for 55 percent efficiency in accordance with ASHRAE Standard 52.

2. High-Efficiency Filters

High-efficiency filters are provided to filter the outside air. The filters are designed for 95 percent efficiency in accordance with ASHRAE Standard 52.

3. Heating Coils

Electric heating coils are provided downstream of the high efficiency filters. The heating coils are designed for adequate heating capacity to temper the outside supply air.

4. Supply Fans

The supply fan provides outside air, which is filtered and heated as required, to the RCB atmosphere. The supply fans are of the vaneaxial type with direct-drive, single-speed motors. The fans have totally enclosed, air-cooled motors, and are statically and dynamically balanced.

5. Exhaust Fans

The exhaust fans exhaust the purge air to the atmosphere via the plant main exhaust duct. The exhaust fans are of the vaneaxial type with direct-drive, single-speed motors. The fans have totally enclosed, air-cooled motors, and are statically and dynamically balanced.

6. Radiation Monitors

   Two redundant radiation monitors are installed outside the RCB in the exhaust duct to monitor the radiation levels in the normal containment purge exhaust air.

9.4.5.2.7 Supplementary Containment Purge Subsystem: The Supplementary Containment Purge Subsystem (Figure 9.4.5-3) is designed as nonsafety and nonseismic except the containment isolation valves, piping, and the radiation monitors, which are safety-related and seismic Category I. This system operates during normal plant operating conditions. Operation of the Supplementary Containment Purge Subsystem enables sufficient reduction in Containment airborne radioactive levels to allow inspection access to the RCB. This subsystem is designed for a smaller flow rate than the Normal Purge Subsystem in order to reduce the size of the Containment penetration isolation valves. The frequency of operation of the Supplementary Containment Purge Subsystem can be found in the Technical Specifications.

This subsystem can be utilized as a nonsafety system to dilute the hydrogen concentration in the Containment atmosphere after a LOCA as described in Section 6.2.5. This subsystem can be utilized to maintain the normal Containment pressure within the limits described in Table 3.ll-l.

Analyses have been performed to justify the Supplementary Containment Purge Subsystem design as specified by BTP CSB 6-4. See Section 15.6.5 for the assumptions and resulting doses form purge operation coincident with a LOCA. The effects of these purge lines on ECCS backpressure is included in the analysis presented in Section 6.2.1.5.

The Supplementary Containment Purge Subsystem consists of one l00-percent-capacity AHU with two l00-percent-capacity supply fans and two l00-percent-capacity exhaust fans. The following is a brief description of the various components that comprise this subsystem.

1. Prefilter

   The prefilters are provided upstream of the high efficiency filters to protect them from coarse particles and are designed for 55 percent efficiency in accordance with ASHRAE Standard 52.

2. High Efficiency Filters

   High efficiency filters are provided to filter the outside air. The filters are designed for 95 percent efficiency in accordance with ASHRAE Standard 52.

3. Heating Coil

   An electric heating coil is provided downstream of the high efficiency filters. The heating coil is designed for adequate heating capacity to temper the outside supply air.

4. Supply Fans

   The supply fans provide outside air, which is filtered and heated as required, to the RCB atmosphere. The supply fans are of the centrifugal type with direct-drive, single-speed motors. The fans have totally enclosed, fan-cooled motors, and are statically and dynamically balanced.

5. Exhaust Fans

The exhaust fans exhaust the purge air to the atmosphere via the plant main exhaust duct. The exhaust fans are of the centrifugal type with direct-drive, single-speed motors. The fans have totally enclosed, fan-cooled motors, and are statically and dynamically balanced.

6. Exhaust Prefilter

The exhaust prefilters are provided upstream of the high efficiency exhaust filters to protect them from coarse particles and are designed for $\geq$ 55 percent efficiency in accordance with ASHRAE Standard 52.

7. HEPA Filter

The exhaust HEPA filters are provided to filter the air coming from the Reactor Containment Building prior to being exhausted through the plant vent. The filters are designed for 99.97 percent efficiency in accordance with N509-1980.

8. Radiation Monitors

The two radiation monitors which are installed to monitor the normal purge exhaust also are used to monitor the radiation levels in the supplementary containment purge exhaust air.

9.4.5.2.8 Tendon Gallery Tunnel Ventilation Subsystem: The Tendon Gallery Tunnel Ventilation Subsystem (Figure 9.4.5-6), designed as nonsafety and nonseismic, operates during normal plant operating conditions to ventilate the tendon gallery tunnel for personnel access and to prevent odor stagnation.

This subsystem consists of two 50-percent-capacity vaneaxial type fans with direct-drive, single-speed motors. Fans have totally enclosed, air-cooled motors, and are statically and dynamically balanced.

Cool air is supplied to the tendon gallery from the MAB Main Supply and Exhaust Subsystem and is exhausted to the atmosphere by the exhaust fans.

9.4.5.2.9 Elevator Machine Room Ventilation Subsystem: The Elevator Machine Room Ventilation Subsystem (Figure 9.4.5-6), designed as nonsafety and nonseismic, operates during normal plant operating conditions to remove equipment heat. The subsystem consists of one 100-percent-capacity centrifugal type fan with belt drive.

The ventilation air is drawn into the Elevator Machine Room from the Containment and then exhausted into the Containment.

9.4.5.2.10 RCB Chilled Water Subsystem: The RCB Chilled Water Subsystem (Figure 9.4.5-5) is designed, as nonsafety and nonseismic, and operates only during normal plant operating conditions. This subsystem provides chilled water to the RCFC units. The RCB Chilled Water

Subsystem consists of three 50-percent-capacity chillers and chilled water pumps. The following is a brief description of the chiller and chilled water pumps:

1. Water Chillers

   The water chillers are of the centrifugal type with water-cooled condensers. Heat is rejected from water-cooled condensers to the auxiliary cooling water system. The main loads on the chilled water system (RCFCs) do not have temperature control loops associated with them and the outlet temperature of the RCFCs is controlled by varying the chilled water header temperature.

2. Chilled Water Pumps

   Chilled water pumps, located upstream of the water chillers, are of the centrifugal type with single-speed, dripproof, electric drive. Pumps are designed to handle the design chilled water flow at the expected head.

9.4.5.2.11 Instrumentation Application: Provisions are made for remote manual control with status indicating lights in the CR for the following Containment HVAC components:

1. RCFC fans
2. Containment cubicles exhaust fans
3. RCFC cooling coil inlet and outlet valves CCW
4. Containment carbon unit fans
5. Normal Containment purge supply and exhaust fans
6. Supplementary Containment purge supply and exhaust fans
7. CRDM ventilation fans
8. Reactor cavity ventilation fans
9. Reactor supports exhaust fans
10. Tendon gallery tunnel ventilation fans
11. Supplementary Containment purge - Containment isolation valves
12. Normal Containment purge - Containment isolation valves
13. Water chillers and chilled water pumps

Provisions are also made for control of the RCFC fans, Containment cubicle exhaust fans, CRDM vent fans, and reactor cavity fans from a transfer switch panel.

Instrumentation requirements for the RCFC Subsystem are discussed in Section 6.2.2.5.2.

Local differential pressure indicators are provided across the filter banks (except the carbon filter banks) on the Containment Carbon Units. A common differential pressure indicator and alarm across the entire filtration train is provided. Temperature switches on each carbon filter signal alarms on a visual annunciator system on the fire protection local panel with retransmission to the data acquisition system in the main CR when high or high-high air temperature exists in the carbon unit. Pneumatic dampers on inlet of filtration trains and discharge side of fans automatically open before start of the corresponding fan. Local pressure differential indicators with CR alarms are provided for Containment cubicles exhaust fans.

Local pressure differential indicators are furnished across each prefilter and high efficiency filter bank. In addition, a common pressure differential indicator with alarm is provided for the Normal and Supplementary Purge Subsystems. The electric heating coil on the supply train is controlled by a temperature sensor located at the heater outlet. Two radiation monitors in series on the exhaust duct of the normal purge provide signals to the RMS. These monitors are also used to monitor the exhaust duct of the supplementary purge by the use of manual valving. (See Section ll.5 for a description of the Process and Effluent Radiological Monitoring and Sampling System.) Flow controllers located on the fan discharge in the normal and Supplementary Containment Purge Subsystem modulate inlet dampers to maintain the required Containment purge supply rate. The Normal and Supplementary Containment Purge Subsystems Containment isolation valves are automatically closed by a Containment ventilation isolation signal from the Solid-State Protection System (SSPS).

A damper limit switch on the CRDM fan discharge damper is used to alarm no flow from the CRDM fans.

See Figures 9.4.5-1 through 9.4.5-6 for other instrumentation and locations.

9.4.5.3 Safety Evaluation. Continued operation of system components is assured by the following features:

1. Safety-related components are designed to pertinent safety class (Section 3.2) and seismic Category I requirements. Safety-related components are located such that failure of portions of other nonessential systems will not prevent operation of any safety-related system.

2. Adequate redundancy is provided for safety-related components to meet the single active failure criterion (see Table 9.4-5.5 for FMEA).

3. By virtue of their location within seismic Category I buildings, the safety-related components are tornado-, missile-, and flood-protected. Safety-related system components are protected from the effects of high and moderate-energy line breaks postulated in Section 3.6.

4. The CRDM Ventilation Subsystem is not required to operate after LOCA; however, when normal power supply is interrupted and the reactor is maintained at hot standby, the CRDM Ventilation Subsystem is operable from the ESF power train. This arrangement prevents damage to the CRDM components.

5. The Reactor Cavity and Support Ventilation Subsystem is provided with two l00-percent-capacity trains and is powered from the ESF busses to assure maintenance of design flow during normal operation and to prevent excessive heat buildup during LOOP.

6. The Normal Containment Purge Subsystem isolation valves at the Containment wall are designed to fail as-is, in the event of loss of power. Interlocks are provided to automatically

close the valves upon Containment ventilation isolation signal. These valves normally remain closed.

7. The Containment isolation valves located inside Containment for the lines serving the Supplementary Containment Purge Subsystem are designed to fail as-is, in the event of loss of power. The other isolation valves located outside the Containment are quick-closure, fail-closed pneumatic valves. Interlocks are provided to automatically close the valves upon Containment ventilation isolation signal.

8. The RCFC Subsystem assures adequate mixing of the RCB atmosphere to prevent formation of pockets with high concentration of hydrogen during post-LOCA operation.

   The basis for the layout of the RCFC supply and return air ducts is to provide adequate mixing of the Containment atmosphere.

9. To achieve fast closure of Containment purge isolation valves, Containment purging is divided into two subsystems; one for shutdown only (Normal Containment Purge Subsystem) and one for normal plant operation (Supplementary Containment Purge Subsystem). The Supplementary Subsystem is designed with low flow rate, thus requiring smaller isolation valves and enabling faster closure time.

10. The expected activity inside Containment during normal operation can be found in Section 12.2 and annual releases are tabulated in Section 11.3.

9.4.5.4 Inspection and Testing Requirements. To assure and demonstrate the capability of the RCB HVAC System to perform the assigned function, tests are performed to verify proper wiring and control hookup, proper functioning of system components and control devices, and to perform final air balance of the system. A preoperational test is conducted with equipment and controls operational to verify that the system performance meets design requirements. Table 9.4-4 describes the testing requirements for the HEPA and carbon filters.

9.4.6 Diesel Generator Building Heating and Ventilating System

9.4.6.1 Design Bases. The Diesel Generator Building (DGB) Heating and Ventilating (H&V) System is designed to perform the following functions during normal and accident conditions:

Normal Operation

1. Maintain environmental temperatures within the design limits as listed in Table 9.4-l. The listed temperatures provide a suitable environment to ensure proper operation of equipment and controls located within the DGB.

2. Minimize atmospheric dust levels in the DGB to ensure proper operation of electrical and mechanical components.

3. Provide a continuous source of fresh air to purge possible oil fumes from the fuel oil storage tank rooms.

Accident Conditions

Maintain environmental temperatures within the design limits as listed in Table 9.4-l. The listed temperatures provide a suitable environment to ensure proper operation of equipment and controls located within the DGB.

9.4.6.1.1 System Redundancy and Engineered Safety Features Power Supply. The safety-related components are designed to meet the single active failure criterion. This requirement is satisfied by providing one l00-percent-capacity equipment train for each DG room. This equipment train is considered part of the associated DG auxiliary train. Safety-related components are powered from the associated ESF bus to which the standby DG is connected. For the degree of redundancy and ESF power supply, see Table 9.4-1.

9.4.6.2 System Description. The configuration of the DGB H&V System is shown on Figure 9.4.6-1, and principal system components design data are listed in Table 9.4-2.6 and are described in this section. The area being served is shown in the general arrangement drawing listed as Figure 1.2-10 in Table 1.2-1. The system consists of two subsystems as follows:

9.4.6.2.1 DGB Normal Heating and Ventilating Subsystem: The DGB Normal H&V Subsystem is designed to operate only during normal plant operating conditions. This subsystem is designed to maintain the ambient temperature and dust levels within the design conditions when the diesel is not operating and to ventilate the oil tank room with fresh outside air. The temperature is controlled by modulating the outside and return air flow rates. The minimum temperature is maintained by electric unit heaters. The heaters are controlled by a built-in thermostat. The DGB Normal H&V Subsystem is not essential for the plant safe shutdown and is thus powered by the non-Class lE bus. The following is a brief description of the various components that comprise the DGB Normal H&V Subsystem:

1. Intake and Exhaust Louvers: Intake and exhaust louvers are provided in the air intake and exhaust chambers. These louvers, except the oil tank room exhaust air louver, are shared with the DGB Emergency Ventilation Subsystem.

2. Outside Air Intake and Return Dampers: The outside air intake and return dampers are of the opposed-blade, air-operated type. The damper positions are modulated to control the quantities of outside and return air by a room temperature controller. These dampers fail to their respective safe positions when the DGB Emergency Ventilation Subsystem is operating.

3. Filters: Filters are provided to filter the supply air. The filters are designed for 40 percent efficiency based upon ASHRAE Standard 52.

4. Supply Fans: One l00-percent-capacity supply fan is provided for each of the three DG rooms. The supply fans are vaneaxial-type with direct-drive, single-speed motors. The fans have totally enclosed, air-cooled motors and are statically and dynamically balanced.

5. Electric Unit Heaters: Five unit heaters are located in each DG room and one in each supply fan room. Each unit consists of an electric heating element and a propeller type fan with a single-speed, explosion-proof electric motor.

6. Fuel Oil Storage Tank Room Exhaust Fan: One 100-percent-capacity exhaust fan is provided for each of the three oil tank rooms. The exhaust fans are centrifugal type with belt drive,

single-speed motors (totally enclosed air-cooled) which are statically and dynamically balanced. The fans are non-Class 1E, but are powered by their corresponding standby diesel bus in case of LOOP.

7. Fuel Oil Storage Tank Room Fire Dampers: Three-hour-rated fire dampers are provided at the two tank room penetrations for ventilation air intake and exhaust. The fire dampers are fusible link curtain type, with low leakage. In case of fire in the oil tank room the fire dampers close, thereby stopping ventilation.

9.4.6.2.2 DGB Emergency Ventilation Subsystem: The DGB Emergency Ventilation Subsystem is designed to operate when the standby diesel generator (SBDG) is operating to maintain the ambient room temperature within the design conditions.

The air-operated outside air intake and return air dampers for the normal ventilation system fail in the full open and closed positions respectively when this subsystem is started. The supply fan provides air to the DG room which in turn is relieved to the atmosphere via the exhaust chamber. The DGB Emergency Ventilation Subsystem is essential for the plant safe shutdown and is thus powered by the Class lE bus. The system is designed to start automatically with its corresponding DG.

The following is a brief description of the components that comprise the DGB Emergency Ventilation Subsystem:

1. Intake and Exhaust Louvers: Intake and exhaust louvers are provided in the air intake and exhaust chambers. These louvers, except the oil tank room exhaust air louver, are shared with the DGB Normal Heating and Ventilating (H&V) Subsystem.

2. Supply Fans: One l00-percent-capacity supply fan is provided for each of the three DG rooms. The supply fans are vaneaxial-type with direct-drive, single-speed motors. The fans have totally enclosed, air-cooled motors and are statically and dynamically balanced.

9.4.6.2.3 Instrumentation Application: The System intake and recirculation dampers are controlled by temperature controllers. Air flow through the ESF fans is monitored by pressure differential switches across the fan. These fans are operable from both the main CR and the ASP. Each DG room is provided with a high temperature switch to annunciate in the main CR should the room temperature exceed the alarm set point due to inadvertent closure of the supply duct fire damper. Should the closure of a fire damper occur and subsequent ventilation is lost, the remaining two safety trains are available to ensure the safety function.

The following instrumentation is provided in addition to that shown on Figure 9.4.6-1.

- Position indication of intake and recirculation dampers
- Indication of the operational status of fans
- Alarms for trouble with exhaust fans

9.4.6.3 Safety Evaluation. Continued operation of system components is assured by the following features:

1. All safety-related components are designed to pertinent SC (Section 3.2) and seismic Category I requirements. The system is designed such that failure of any nonessential systems will not prevent operation of any safety-related system.

2. Adequate redundancy is provided for safety-related components to meet the single failure criterion (see Table 9.4-5.6 for FMEA).

3. By virtue of their location within missile-protected buildings, the safety-related components are protected against tornado missiles and flooding. Safety-related trains are physically separated from each other thus protecting them from the effects of high and moderate energy line breaks postulated in Section 3.6. This separation also ensures that missiles or fire in any one train do not affect the operation of the other trains. Ventilation air intake and exhaust are located such as to prevent a fire in one train from affecting other trains.

9.4.6.4 Inspection and Testing Requirements. To assure and demonstrate the capability of the DGB Ventilation Subsystem to perform the assigned function, tests are performed to verify proper wiring and control hookup, proper functioning of system components and control devices, and to perform final air balance of the system. A preoperational test is conducted with equipment and controls operational to verify that the system operation meets design requirements. To ensure a continued state of readiness of the DGB Emergency Ventilation Subsystem, plant procedures will be followed to perform periodic inspection, maintenance, and testing.

9.4.7 Miscellaneous Buildings Heating, Ventilating, and Air-Conditioning System

9.4.7.1 Design Bases. The Miscellaneous Buildings HVAC System (Figure 9.4.7-1) is designed in accordance with the following.

1. The system is to perform these functions:

    a. Control the thermal environment within the design limits listed in Table 9.4-1 and provide a suitable atmosphere for personnel and equipment inside the Essential Cooling Water Intake Structure (ECWIS) and various other minor buildings and structures both inside and outside of the Protected Area.

    b. Provide accessibility for adjustments and periodic inspections and testing of the principal system components to ensure continuous functional reliability.

2. The ECWIS is served by an SC 3, seismic Category I ventilation subsystem and is also protected against the effects of natural phenomena, missiles, and flooding. The other subsystems are not safety-related and are non-seismic.

3. Instrumentation and controls are provided for the system to control the environment and system operation within design parameters.

9.4.7.2 System Description. The system configuration of the ECWIS Ventilation Subsystem of the Miscellaneous Buildings HVAC system is shown on Figure 9.4.7-1 and principal components design data for this subsystem are as listed in Table 9.4-2.7 and as described in this section. The remainder of the Miscellaneous Buildings HVAC System is non-safety related and non-seismic, and is not described.

9.4.7.2.1 ECWIS Ventilation Subsystem: The ECWIS Subsystem consists of two 50-percent-capacity ventilation fans per train. The subsystem consists of three trains, for a total of six ventilation fans. Each subsystem has the following components.

1. Dampers

   Air-operated, parallel-blade intake and exhaust dampers are provided for the ventilation fans. Intake and exhaust dampers are interlocked to open when either of the fans is energized. The dampers fail in the open position.

2. Ventilation Fans

   The ventilation fans are designed to maintain the building within the design ambient temperature limits. The fans are propeller type with direct-drive, single-speed motors. The fans are statically and dynamically balanced and have totally enclosed, air-cooled motors.

3. Unit Heaters

   Each unit heater consists of an electric heating element and propeller-type fan with a single-speed, direct-drive electric motor. The unit heaters are designed with adequate heating capacity and air flow to prevent freezing conditions and to prevent hot and cold pockets within the buildings.

The ECWIS Ventilation Subsystem induces outside air into the pump rooms and exhausts this air through dampers to the outside. During shutdown, heating is provided by the unit heaters.

9.4.7.2.2 Instrumentation and Controls: Provisions are made for remote manual control from the CR or MCC of the ECWIS ventilation fans through use of a transfer switch. The ventilation fan inlet and exhaust dampers in each pump room are interlocked to open when either fan starts and to close when both fans stop. Each pump room has two temperature sensors. Each pump room temperature sensor is interlocked to automatically start the associated pump room fan when the room temperature exceeds the sensor's setpoint. An independent temperature switch signals an alarm on the visual annunciator system in the CR if the pump room temperature exceeds the high-high setting of the switch. High-high temperature is also monitored by the ERF Computer.

The ECWIS ventilation fans also start upon receiving an ECW pump start signal (when in CR control mode). Fan status lights are provided at the main CR and the MCC. Bypass/inoperable status indication is provided within the ESF status monitoring system. ERF computer monitoring is provided to show fan status. While temperature start/stop of ECWIS vent fans is an automatic operation with no operator action required, the fan start on pump start is not reset when the pump start signal is removed. Operator action is thus required to stop the fan. During cold weather conditions, when the outside air temperature $\leq 34^{o}F$, the ECWIS ventilation fans may be placed in pull-to-lock to protect the equipment in the ECW pump rooms from freezing and still maintain the temperature in these rooms within the design limits listed in Table 9.4-1, during normal operating conditions.

Further, sufficient time exists for the operators to remove the fans from pull-to-lock during any accident conditions.

9.4.7.3 Safety Evaluation. The ECWIS Ventilation Subsystem is SC 3 and seismic Category I. All other miscellaneous buildings subsystems are non-safety-related and nonseismic.

To assure continued operation of the ECWIS Ventilation Subsystem, the following additional features are incorporated:

1. During LOOP, all active components such as motors, damper operators, controls, and instrumentation are served by their respective independent ESF power train.

2. The subsystem consists of two 50-percent-capacity fans and their associated components for each of the three 50-percent pump cubicles. Redundancy of components ensures that the system meets the single active failure criteria. The system FMEA and effects analysis is presented in Table 9.4-5.7.

3. Protective action of fans is not compromised once the actuation signal is reset.

4. The high-high room temperature alarm detects the inadvertent operation of any nonsafety-related heaters.

5. In the event the CR is unavailable, a second point of control is provided for strictly manual operation.

9.4.7.4 Inspection and Testing Requirements. The ECWIS Ventilation Subsystem is subjected to preoperational testing in accordance with written procedures to verify proper wiring and control hookup, and proper function of system components and control devices, and to perform final air balance of the system. The preoperational test summary for the ECWIS Ventilation Subsystem is discussed in Chapter l4.

9.4.8 Main Steam Isolation Valve Building Ventilation and Heating System

9.4.8.1 Design Bases. The Main Steam Isolation Valve (MSIV) Building Ventilation and Heating System is designed to perform the following functions:

1. Maintain ambient temperatures in the auxiliary feedwater (AFW) pump rooms and valve cubicles within the design limits listed in Table 9.4-1 to provide a suitable environment for proper operation of equipment during normal and accident conditions.

   This is achieved by the use of the isolation valve cubicle ventilation subsystem and by the thermostatically controlled heaters (non-Class 1E). During cold weather conditions when the outside air temperature $\leq$ 34°F, the AFW area vent fans can be placed in pull-to-lock to protect the equipment in the AFW pump cubicles from freezing and still maintain the temperature in these rooms within the design limits listed in Table 9.4-1, during normal operating conditions.

   Further, emergency operating procedures will require the operator to remove the fans from pull-to-lock during any accident conditions.

2. Maintain concrete temperatures in the pipe restraint and penetration areas within the design limits (normal operation only) listed in Table 9.4-1.

Ventilation in these areas is provided by the manually controlled Pipe Restraint Area/Containment Penetration Ventilation Subsystem.

All safety-related components are designed to meet the single active failure criterion. Adequate redundant trains powered from independent ESF busses are provided (Table 9.4-1) for the degree of redundancy and ESF power supply.

9.4.8.2 System Description. The configuration of the MSIV Building Ventilation and Heating System is shown on Figure 9.4.8-1. The principal system components design data are listed in Table 9.4-2.8 and described in this section. The area being served is shown in the general arrangement drawings listed as Figures 1.2-21 through 1.2-25 in Table 1.2-1. The system consists of two subsystems as follows:

9.4.8.2.1 Main Steam Isolation Valve Cubicle Ventilation and Heating Subsystem: The MSIV Cubicle Ventilation Subsystem is designed to operate during normal and accident plant operating conditions and to maintain the ambient temperature in the valve cubicle and pump rooms (Table 9.4-1). The MSIV Cubicle Ventilation Subsystem is essential for plant safe shutdown and is powered by the Class 1E bus.

The supply fans provide outside air to the valve cubicles and pump room below. The air is exhausted to the atmosphere via relief openings at the top of the building.

If the unit is not at power and the outside air temperature is $\leq 34^{\circ}F$, the MSIV cubicle vent fans may be placed in pull-to-lock for freeze protection purposes.

The following is a brief description of the major components that comprise the MSIV Cubicle Ventilation Subsystem.

Supply Fans

One 100-percent-capacity supply fan is provided for each of the four AFW pumps and associated valve cubicles. The supply fans are of the vaneaxial type with direct-drive, single-speed motors. The fans have totally enclosed, air-cooled motors and are statically and dynamically balanced.

The MSIV Cubicle Ventilation Subsystem FMEA is presented in Table 9.4-5.8.

The heating subsystem is designed to operate during normal conditions, to maintain the minimum design room temperature in the valve cubicle and pump room (Table 9.4-1). The heating subsystem is nonsafety-related and is required to operate only during normal conditions. The subsystem consists of electric unit heaters located in the valve cubicle and pump room. Each unit heater includes an electric heating coil and propeller fan with single-speed, direct-drive motor.

9.4.8.2.2 Pipe Restraint Areas, Feedwater Isolation Valve (FWIV) Area and Containment Penetrations Ventilation Subsystem: The Pipe Restraint Area, FWIV Area and Containment Penetrations Ventilation Subsystem operates during normal plant operating conditions to maintain concrete temperature at the pipe restraints and penetrations, and to cool the FWIV Solenoid Dump Valves hydraulic fluid. This subsystem is not essential for plant safe shutdown and is supplied by a non-Class 1E power source.

The supply fans provide outside air to the restraint area, and penetrations. The air is then exhausted to the atmosphere via the same relief openings as used by the MSIV Cubicle Ventilation Subsystem.

The following is a brief description of the major components that compromise this subsystem.

Supply Fans

Two 100-percent-capacity supply fans are provided for the pipe restraints and penetrations in each of the four valve/pump cubicles. The supply fans are vaneaxial type with direct-drive, single-speed motors. The fans have totally enclosed, air-cooled motors and are statically and dynamically balanced.

9.4.8.2.3 Instrumentation Application: Instrumentation and controls are provided for the system to control the ambient temperature and system operation within design parameters, to inform the operator should any malfunction occur.

Provisions are made for remote manual control of MSIV Cubicle ventilation fans from the main CR. MSIV ventilation fans are automatically started upon the following conditions:

- Each fan's respective AFW pump starts.
- Valve cubicle high temperature. A high cubicle temperature switch starts the fan if the cubicle temperature exceeds the high setting of the switch. ESF monitoring and bypass status inoperative status for the ventilation fans are provided.

Temperature high-high alarms for pump rooms are tied to a common window in the main control board annunciator system and are shown on the ERF computer.

The pipe restraint/penetration area fans are manually controlled from the main CR. Trip of one fan automatically starts the standby fan for that area.

The heating subsystem unit heaters are thermostatically controlled.

9.4.8.3 Safety Evaluation. Continued operation of the MSIV Cubicle Ventilation Subsystem components is assured by the following features.

1. The safety-related components are designed to SC 3 and seismic Category I requirements. The nonsafety-related systems are designed and supported such that any failure will not prevent operation of any safety-related system.

2. Adequate redundancy is provided for safety-related components to meet the single failure criterion (see Table 9.4-5.8 for failure modes and effects analysis).

3. The four ventilation systems for the four trains of pump/valve cubicle areas are physically separated from each other such that a high energy line break in one train does not affect the operation of the other three trains.

4. By virtue of their location, the safety-related components are protected against flooding and horizontal missiles such that more than one train is not jeopardized with a single missile.

9.4.8.4 Inspection and Testing Requirements. Tests are performed to verify proper wiring and control devices, and to perform final air balance of the system. A preoperational test is conducted with equipment and controls operational to verify that the system operation meets design requirements. To ensure a continued state of readiness of the MSIV Cubicle Ventilation Subsystem, the plant procedures will be followed to perform periodic inspection, maintenance, and testing.

TABLE 9.4-1

HVAC SYSTEMS PARAMETERS

HVAC Systems & Subsystems	Normal Parameters Temp., (1) °F DB, RH%	Maximum Parameters Temp., (1) °F DB, RH%	1E Power Required	Degree of Redundancy (Major Components)	Operation Under Postulated Accident Conditions	Provision for Rad. Monitoring at Release Point	Remarks
Control Room & Electrical Aux. Bldg. HVAC System							
a) Control Room Envelope HVAC Subsystem	-	-	All components except exhaust fan, heating coils & computer room HVAC	3 - 50%	Yes	None	Safety Class 3 Seismic Cat I except for exhaust fan, heating coil & computer room HVAC which are non safety class.
1) Control Room Living Quarters	78°F, Max 72°F, Min 20 - 80% RH	78°F, 80% RH	-	-	-	-	
2) Relay Room	80°F, Max 72°F, Min 20 - 80% RH	80°F, 80% RH	-	-	-	-	
3) Computer Room	77°F, Max 60°F, Min 40 - 60% RH	77°F, 60% RH[5]	-	-	-	-	
4) HVAC Rooms	104°F Max 50°F Min 20 - 80% RH	104°F, 80% RH					
b) EAB Main Area HVAC Subsystem	-	-	All components except heating coils[4], ele-room fan	3 - 50%	Yes	None	Safety Class 3 Seismic Cat I except for heating coils which are nonsafety class, elevator machine room fan, and Electrical Penetration Normal HVAC.

1. Area temperature maintained by system, RH is not a controlled parameter unless otherwise noted.
2. During loss of offsite power only by manually loading to 1E buses.
3. Average concrete temperature: 150°F. Maximum concrete temperature: 200°F (Local areas only, e.g., vessel supports). Normal maximum temperature for neutron detectors: 135°F.
4. The heating coils do not require ESF power except for the heating coils for the ESF Battery Rooms.
5. Relative Humidity is a controlled parameter.

TABLE 9.4-1 (Continued)

HVAC SYSTEM PARAMETERS

HVAC Systems & Subsystems	Normal Parameters Temp., (1) °F DB, RH%	Maximum Parameters Temp., (1) °F DB, RH%	1E Power Required	Degree of Redundancy (Major Components)	Operation Under Postulated Accident Conditions	Provision for Rad. Monitoring at Release Point	Remarks
1) Elect. Equip. and Cable Areas	104°F, Max 50°F, Min 20 - 80% RH	104°F, 80% RH	-	-	-	-	
2) Battery Rooms	77°F, Max 70°F, Min 20 - 80% RH	77°F, 80% RH	-	-	-	-	
3) Occupied Areas	78°F, Max 72°F, Min 20 - 80% RH	78°F, 80% RH	-	-	-	-	CAS Room Maximum 75°F
4) HVAC Rooms	104°F, Max 50°F, Min 20 - 80% RH	104°F, 80% RH	-	-	-	-	
c) TSC HVAC Subsystem			No	2 - 100% supply & return fans, water chiller and pumps computer room AHUs.	Yes	None	Nonsafety- related system, provided with reliable non-Class 1E power source except for exhaust fan & heating coils.
1) Computer Room	77°F, Max 60°F, Min 40-60% RH	77°F, 60% RH(5)					
2) HVAC Room	104°F, Max 50°F, Min 20 - 80% RH	104°F, 80% RH					
3) Remaining Areas	78°F, Max 72°F, Min 20 - 80% RH	78°F, 80% RH					

1. Area temperature maintained by system, RH is not a controlled parameter unless otherwise noted.
2. During loss of offsite power only by manually loading to 1E buses.
3. Average concrete temperature: 150°F. Maximum concrete temperature: 200°F (Local areas only, e.g., vessel supports). Normal maximum temperature for neutron detectors: 135°F.
4. The heating coils do not require ESF power except for the heating coils for the ESF Battery Rooms.
5. Relative Humidity is a controlled parameter.

TABLE 9.4-1 (Continued)

HVAC SYSTEMS PARAMETERS

HVAC Systems & Subsystems	Normal Parameters Temp., (1) °F DB, RH%	Maximum Parameters Temp., (1) °F DB, RH%	1E Power Required	Degree of Redundancy (Major Components)	Operation Under Postulated Accident Conditions	Provision for Rad. Monitoring at Release Point	Remarks
Mechanical Aux. Bldg. System							
a) Main Supply and Exhaust Subsystem	104°F, Max 50°F, Min (except as noted) 20 - 80% RH	104°F, 80% RH (except as noted)					
1) Supply Fan			No	3 - 50%	No	No	
2) Filtration Unit			No	4 - 25%	No	No	
3) Cooling Coil			No	4 - 25%	No	No	
4) Heating Coils			No	4 - 25%	No	No	
5) Exhaust Fans			No	3 - 50%	No	No	
Rooms 068F, 068H 325, & 325A	85°F, Max 50°F, Min 20 - 80% RH						
Rooms 217B & 218	(78°F, Max for Room 218) (104°F, Max for Room 217B) 50°F, Min 20 - 80% RH		NA				
Room 064A	109°F, Max 50°F, Min 20 - 80% RH	109°F					
b) Supplementary Cubicle Cooler Subsystem							
1) CCW Pump Cooler Rooms 067, 067E, 067F	115°F, Max 50°F, Min 20 - 80%	120°F, 80% RH	Yes	1 - 100% per pump	Yes	N/A	

1. Area temperature maintained by system, RH is not a controlled parameter unless otherwise noted.
2. During loss of offsite power only by manually loading to 1E buses.
3. Average concrete temperature: 150°F. Maximum concrete temperature: 200°F (Local areas only, e.g., vessel supports). Normal maximum temperature for neutron detectors: 135°F.
4. The heating coils do not require ESF power except for the heating coils for the ESF Battery Rooms.

TABLE 9.4-1 (Continued)

HVAC SYSTEMS PARAMETERS

HVAC Systems & Subsystems	Normal Parameters Temp., (1) °F DB, RH%	Maximum Parameters Temp., (1) °F DB, RH%	1E Power Required	Degree of Redundancy (Major Components)	Operation Under Postulated Accident Conditions	Provision for Rad. Monitoring at Release Point	Remarks
2) Centrifugal Charging Pump 039, 041	135°F, Max 50°F, Min 20 - 80% RH	135°F, 80% RH	Yes	1 - 100% per pump	Yes	N/A	
3) Essential Chiller Rooms Nos. 67, 67E, 67F	115°F, Max 50°F, Min	120°F, 80% RH	Yes	1 - 100% per chiller	Yes	N/A	
4) Boric Acid Transfer Pump Room No. 18	104°F, Max 50°F, Min	104°F, 80% RH	Yes	2 - 100%	Yes	N/A	
5) CVCS Valve Rooms Cubicles No. 033 No. 044 No. 226	104°F, Max 50°F, Min	104°F, 80% RH	Yes	 2 - 100% 1 - 100% 2 - 100%	Yes	N/A	
6) Reactor Makeup Water Storage Tank Room No. 62	104°F, Max 50°F, Min	104°F, 80% RH	Yes	2 - 100%	Yes	N/A	
7) Radwaste Control Room No. 217	78°F, Max 50°F, Min	78°F, 80% RH	No	2 - 100%	No	N/A	
8) Radiation Monitor Room No. 327A	104°F, Max 50°F, Min	104°F, 80% RH	Yes	2 - 100%	Yes	N/A	
9) Positive Displacement Charging Pump Room Cooler	135°F, Max 50°F, Min 20 - 80% RH	N/A	No	1 - 100%	No	N/A	Nonsafety system provided with reliable power source (TSC diesel)

1. Area temperature maintained by system, RH is not a controlled parameter unless otherwise noted.
2. During loss of offsite power only by manually loading to 1E buses.
3. Average concrete temperature: 150°F. Maximum concrete temperature: 200°F (Local areas only, e.g., vessel supports). Normal maximum temperature for neutron detectors: 135°F.
4. The heating coils do not require ESF power except for the heating coils for the ESF Battery Rooms.

TABLE 9.4-1 (Continued)

HVAC SYSTEMS PARAMETERS

HVAC Systems & Subsystems	Normal Parameters Temp., (1) °F DB, RH%	Maximum Parameters Temp., (1) °F DB, RH%	1E Power Required	Degree of Redundancy (Major Components)	Operation Under Postulated Accident Conditions	Provision for Rad. Monitoring at Release Point	Remarks
10) Radwaste Counting Room No. 231	79°F, Max 68°F, Min 20 -80%	79°F, 80% RH	No	1 - 100%	Not Required (See remarks)	N/A Yes	Power available from TSC Diesel, thus cooling available in the event of loss of offsite power.
c) Supplementary Supply Exhaust Subsystem	75°F, Max 72°F, Min	75°F, 80% RH					
1) Supply Fans			No	2 - 100%	No		
2) Filter			No	1 - 100%	No		
3) Heating Coil			No	1 - 100%	No		
4) Cooling Coil			No	1 - 100%	No		
5) Package Filter Units			No	1 - 100%	No		Filter units are per lab room cross-tied to maintain negative pressure in laboratory - areas where Maintenance is being performed on one filter unit.
6) Exhaust Fans			No	2 - 100%	No		
d) MAB Chilled Water Subsystem							
1) Chillers			No	3 - 33-1/3% (Unit 1) 4 - 33-1/3% (Unit 2)	No	N/A	
2) Pumps			No	4 - 33-1/3%	No	N/A	
RCB HVAC System	120°F, Max 65°F, Min (except as noted) 0 - 70% RH	323°F, 100% RH (except as noted)	See each Subsystem	See each Subsystem	See each Subsystem	See each Subsystem	

1. Area temperature maintained by system, RH is not a controlled parameter unless otherwise noted.
2. During loss of offsite power only by manually loading to 1E buses.
3. Average concrete temperature: 150°F. Maximum concrete temperature: 200°F (Local areas only, e.g., vessel supports). Normal maximum temperature for neutron detectors: 135°F.
4. The heating coils do not require ESF power except for the heating coils for the ESF Battery Rooms.

TABLE 9.4-1 (Continued)

HVAC SYSTEMS PARAMETERS

HVAC Systems & Subsystems	Normal Parameters Temp., (1) °F DB, RH%	Maximum Parameters Temp., (1) °F DB, RH%	1E Power Required	Degree of Redundancy (Major Components)	Operation Under Postulated Accident Conditions	Provision for Rad. Monitoring at Release Point	Remarks
a) RCFC Subsystem	110°F, Max 65°F, Min 0 - 70% RH	330°F, 100%	Yes	6 - 25% (Normal) 6 - 33-1/3% (DBA)	Yes	N/A	
b) Containment Cubicles Exhaust Subsystem	120°F, Max N/A, Min	N/A	Yes	Two 100% fans on each of two 50% capacity trains	No	N/A	a. Except pressurizer area temperature of 150°F. b. Operable during all modes of Plant operation except Post-LOCA
c) Containment Carbon Units Subsystems	N/A, Max N/A, Min	N/A	No	Two 100% fans on each of two carbon units 50% capacity	No	N/A	
d) CRDM Ventilation Subsystem	200°F, Max N/A, Min	N/A	Yes(2)	3 - 50%	No	N/A	
e) Reactor Cavity and Support Ventilation Subsystem	135°F, Max(3) 65°F, Min	N/A	Yes(2)	2 - 100%	No	N/A	
f) Normal Containment Purge Subsystem	N/A, Max 65°F, Min(Discharge Air)	N/A	No	Supply Fans (2 - 100%) Exhaust Fans (2 - 100%) Filters (1 - 100% train)	No	Yes	

1. Area temperature maintained by system, RH is not a controlled parameter unless otherwise noted.
2. During loss of offsite power only by manually loading to 1E buses.
3. Average concrete temperature: 150°F. Maximum concrete temperature: 200°F (Local areas only, e.g., vessel supports).
4. The heating coils do not require ESF power except for the heating coils for the ESF Battery Rooms.

TABLE 9.4-1 (Continued)

HVAC SYSTEMS PARAMETERS

HVAC Systems & Subsystems	Normal Parameters Temp., (1) °F DB, RH%	Maximum Parameters Temp., (1) °F DB, RH%	1E Power Required	Degree of Redundancy (Major Components)	Operation Under Postulated Accident Conditions	Provision for Rad. Monitoring at Release Point	Remarks
g) Supplementary Purge Subsystem	N/A, Max 65°F, Min (Discharge Air)	N/A	No	Supply fans (2 - 100%) Exhaust fans (2 - 100%) Filters (1 – 100% train)	Yes (See Remarks)	Yes	Available post-LOCA on a non-safety function basis.
h) Tendon Access Gallery Ventilation Subsystem	95°F, Max 50°F, Min	N/A	No	2 - 50%	No	No	This subsystem is outside the Containment Building.
i) RCB Chilled Water Subsystem	N/A	N/A	No	3 - 50%	No	N/A	
FHB HVAC System							
a) Supply Subsystem	104°F, Max 65°F, Min	N/A	No	3 - 50% trains Filters (3 - 50%)	No	None	
b) Exhaust Subsystem	104°F, Max 65°F, Min	120°F	Yes	3 - 50% Main exhaust fans 3 - 50% Exhaust booster fans 2 - 100% Filter trains Each has 3 - 33-1/3% filter units	Yes	Yes	

1. Area temperature maintained by system, RH is not a controlled parameter unless otherwise noted.
2. During loss of offsite power only by manually loading to 1E buses.
3. Average concrete temperature: 150°F. Maximum concrete temperature: 200°F (Local areas only, e.g., vessel supports). Normal maximum temperature for neutron detectors: 135°F.
4. The heating coils do not require ESF power except for the heating coils for the ESF Battery Rooms.

TABLE 9.4-1 (Continued)

HVAC SYSTEMS PARAMETERS

HVAC Systems & Subsystems	Normal Parameters Temp., (1) °F DB, RH%	Maximum Parameters Temp., (1) °F DB, RH%	1E Power Required	Degree of Redundancy (Major Components)	Operation Under Postulated Accident Conditions	Provision for Rad. Monitoring at Release Point	Remarks
c) Supplementary Coolers Subsystem(except PASS)	104°F, Max 65°F, Min	120°F, 80% RH	Yes	1 - 100% per cubicle	Yes	N/A	
d) PASS Supplementary Cooler	75°F, Max 65°F, Min	104°F, 80% RH	No	1 - 100%	Not required (see remarks)	N/A	Power available from TSC diesel, thus cooling should be available in the event of loss of offsite power
DGB HVAC System							
a) Normal H&V Subsystem	104°F, Max 50°F, Min	104°F	No	1-100% per Diesel Train	No	None	
b) Emergency Ventilation Subsystem	120°F, Max 50°F, Min	120°F	Yes	1-100% per Diesel Train	Yes	None	120°F max and 50°F min are based on diesel operating
c) Fuel Oil Tank Room Exhaust System	120°F, Max 29°F, Min	120°F	Yes	1 - 100% per Diesel Train	Yes		Exhaust fans are nonsafety but are supplied by 1E power
TGB HVAC System							
a) Ventilation Subsystem	110°F, Max 50°F, Min	N/A	No	None (except 2 - 100% exhaust fans for high heat loads)	No	None	except: DG non-1E Emergency Diesel Room during operation, 120°F

1. Area temperature maintained by system, RH is not a controlled parameter unless otherwise noted.
2. During loss of offsite power only by manually loading to 1E buses.
3. Average concrete temperature: 150°F. Maximum concrete temperature: 200°F (Local areas only, e.g., vessel supports). Normal maximum temperature for neutron detectors: 135°F.

TABLE 9.4-1 (Continued)

HVAC SYSTEMS PARAMETERS

HVAC Systems & Subsystems	Normal Parameters Temp., (1) °F DB, RH%	Maximum Parameters Temp., (1) °F DB, RH%	1E Power Required	Degree of Redundancy (Major Components)	Operation Under Postulated Accident Conditions	Provision for Rad. Monitoring at Release Point	Remarks
b) Supplementary Subsystem	104°F, Max 50°F, Min 120°F (Diesel Generator Room during operation) (See Remarks)	N/A	No	None (except 2 - 100% Battery Room Exhaust Fans)	No	None	except: 1. Battery Room 77°F ± 5°F 2. Cold Chemistry Lab Area 77°F ±2°F 3. Excitation Room 72°F -75°F 4. Operator's Room 75°F -80°F

1. Area temperature maintained by system, RH is not a controlled parameter unless otherwise noted.
2. During loss of offsite power only by manually loading to 1E buses.
3. Average concrete temperature: 150°F. Maximum concrete temperature: 200°F (Local areas only, e.g., vessel supports). Normal maximum temperature for neutron detectors: 135°F.
4. The heating coils do not require ESF power except for the heating coils for the ESF Battery Rooms.

TABLE 9.4-1 (Continued)

HVAC SYSTEMS PARAMETERS

HVAC Systems & Subsystems	Normal Parameters Temp., (1) °F DB, RH%	Maximum Parameters Temp., (1) °F DB, RH%	1E Power Required	Degree of Redundancy (Major Components)	Operation Under Postulated Accident Conditions	Provision for Rad. Monitoring at Release Point	Remarks
ECWIS Ventilation Subsystem	104°F, Max 50°F, Min	104°F	Yes	2 - 50% per pump room	Yes	None	With no heaters and pumps running the minimum room temperature is34°F.
MSIV BLDG. HVAC System							
a) MSIV Cubicle Ventilation Subsystem			Yes	1 - 100% fans per pump/valve room	Yes	None	Minimum temperature for emergency is 35°F. During normal operations the minimum temperature is maintained by non-1E heaters
- AFW Pump Rooms 005 & 101,006 & 102, 007 & 103	104°F, Max 50°F, Min 20 - 80% RH	107°F, 80% RH					
- AFW Pump Room 008 & 104	104°F, Max 50°F, Min 20 - 80% RH	104°F, 80% RH					
- Isolation Valve Cubicles 201, 301, 401, 501, 202, 302, 402, 502, 203, 303, 403, 503	104°F, Max 50°F, Min 20 - 80% RH	106°F, 80% RH					

1. Area temperature maintained by system, RH is not a controlled parameter unless otherwise noted.
2. During loss of offsite power only by manually loading to 1E buses.
3. Average concrete temperature: 150°F. Maximum concrete temperature: 200°F (Local areas only, e.g., vessel supports). Normal maximum temperature for neutron detectors: 135°F.
4. The heating coils do not require ESF power except for the heating coils for the ESF Battery Rooms.

TABLE 9.4-1 (Continued)

HVAC SYSTEMS PARAMETERS

HVAC Systems & Subsystems	Normal Parameters Temp., (1) °F DB, RH%	Maximum Parameters Temp., (1) °F DB, RH%	1E Power Required	Degree of Redundancy (Major Components)	Operation Under Postulated Accident Conditions	Provision for Rad. Monitoring at Release Point	Remarks
- Isolation Valve Cubicle 204, 304, 404, 504	104°F, Max 50°F, Min 20 - 80% RH	104°F, 80% RH					
b) Pipe Restraint & Penetration area ventilation subsystem	150°F, Max 29°F, Min 20 - 80% RH	200°F, 80% RH	No	2 - 100% fan	No	None	Temperatures given are for concrete

1. Area temperature maintained by system, RH is not a controlled parameter unless otherwise noted.
2. During loss of offsite power only by manually loading to 1E buses.
3. Average concrete temperature: 150°F. Maximum concrete temperature: 200°F (Local areas only, e.g., vessel supports). Normal maximum temperature for neutron detectors: 135°F.
4. The heating coils do not require ESF power except for the heating coils for the ESF Battery Rooms.

TABLE 9.4-2.1

DESIGN DATA FOR CONTROL ROOM, ELECTRICAL AUXILIARY BUILDING, AND TSC HVAC SYSTEM

I. Control Room Envelope HVAC System.

1. Main Air-Handling Unit

There are three 50-percent-capacity main air-handling units, each having the following data:

a. Fan/Coil

Type of fan	Centrifugal
Fan air flow capacity, scfm	17,400
Fan static pressure, in. wg	10.2
Fan motor, hp/rpm	50/1800
Type of cooling coil	Chilled water
Cooling capacity, Btu/hr	840,000 (Total) 805,850 (Sensible)

b. Prefilters

Type	Throwaway
Filter efficiency (ASHRAE Std. 52)	30%
Filter pressure drop (dirty), in. wg	0.5

c. High-efficiency filters:

Type	Dry/Extended medium
Filter efficiency (ASHRAE Std. 52)	95%
Filter pressure drop (dirty), in. wg	1.5

2. Return Fan

There are three 50-percent-capacity return air fans, each having the following data:

Type of fan	Vaneaxial air flow
Capacity, scfm	16,400
Static pressure, in. wg	6
Fan motor, hp/rpm	30/1,800
Type of drive	Direct

TABLE 9.4-2.1 (Continued)

DESIGN DATA FOR CONTROL ROOM, ELECTRICAL AUXILIARY BUILDING, AND TSC HVAC SYSTEM

3. Makeup Air Unit

There are three 50-percent-capacity makeup air units, each sized for 1,000 ft^3/min. Each makeup air unit consists of the following components.

a. Prefilters

Number of cells in set	1
Each cell airflow capacity, scfm	1,000
Filter efficiency (ASHRAE Std. 52)	85%
Filter pressure drop (dirty), in. wg	1.0

b. HEPA Filters

Each makeup unit has two sets of HEPA filter banks, one bank upstream and one downstream of the carbon filter. The following is the data for each HEPA filter bank:

Number of cells in set	1
Each cell air flow, scfm	1,000
Filter efficiency (DOP Smoke Test)	99.97%
Filter pressure drop (dirty), in. wg	2.0

c. Carbon Filters

Number of cells	1 x 3
Each cell air flow capacity, scfm	333
Charcoal bed depth, in.	2
Filter efficiency for removal of	
elemental iodine	95%
methyl iodide	95%
Filter pressure drop (dirty), in. wg	1.0

d. Electric Heating Coil

Capacity, kW	4.5
No. of steps	1
Pressure drop, in. wg	0.1

TABLE 9.4-2.1 (Continued)

DESIGN DATA FOR CONTROL ROOM, ELECTRICAL AUXILIARY BUILDING, AND TSC HVAC SYSTEM

3. Makeup Air Unit (Continued)

e. Fan

Type	Centrifugal
Air flow capacity, scfm	1,000
Static pressure capability, in. wg	9.0
Motor, hp/rpm	5/3,600
Type of drive	Direct

4. Control Room Air Cleanup Unit

There are four 50-percent-capacity control room air cleanup units, each sized for 6,000 ft^3/min. Each air cleanup unit consists of the following components:

a. Prefilters

Number of cells in set (wide x high)	2 x 3
Each cell air flow capacity, scfm	1,000
Filter efficiency (ASHRAE Std. 52)	85%
Filter pressure drop (dirty), in. wg	1.0

b. HEPA Filters

Each cleanup unit has two sets of HEPA filter banks, one bank upstream and one downstream of the carbon filter. Following are the data for each HEPA filter bank:

Number of cells in bank(wide x high)	2 x 3
Each cell airflow, scfm	1,000
Filter efficiency (DOP Smoke Test)	99.97%
Filter pressure drop (dirty), in. wg	2.0

c. Carbon Filters

Number of cells (wide x high)	2 x 9
Each cell air flow, scfm	333
Charcoal bed depth, in.	2

TABLE 9.4-2.1 (Continued)

DESIGN DATA FOR CONTROL ROOM, ELECTRICAL AUXILIARY BUILDING, AND TSC HVAC SYSTEM

4. Control Room Air Cleanup Unit (Continued)

c. Carbon Filters (Continued)

Filter efficiency for removal of	
elemental iodine	95%
methyl iodide	95%
Filter pressure drop (dirty), in. wg	1.0

d. Fan

Type	Centrifugal
Capacity airflow, scfm	6,000
Static pressure capability, in. wg	9
Motor, hp/rpm	15/1,200
Type of drive	Direct

5. Duct Reheat Coils

There are four duct reheat coils, with the following data:

Type of coil	Electric, open coil
Capacity, kW	43/60/65/5

6. Exhaust Air Fan

There is one 100-percent-capacity exhaust air fan, with the following data:

Type	Inline centrifugal
Air flow capacity, scfm	1,000
Static pressure, in. wg	2.5
Fan motor, hp/rpm	1.5/1,725
Type of drive	Belt

7. Computer Room Air Handling Unit (Control Room and TSC)

There are two 100-percent-capacity computer room air-handling units, each with the following data:

Type of units	Downblast, floor plenum
Type of fan	Discharge Centrifugal
Fan air flow, scfm	11,400
Exhaust fan static pressure, in. wg	0.5
Fan motor, hp/rpm	7.5/1,800
Type of heating coil	Electric, fin tube

TABLE 9.4-2.1 (Continued)

DESIGN DATA FOR CONTROL ROOM, ELECTRICAL AUXILIARY BUILDING, AND TSC HVAC SYSTEM

7. Computer Room Air Handling Unit (Control Room and TSC) (Continued)

Heating coil capacity, kW	30
Type of cooling coil	Chilled water
Cooling coil capacity, Btu/hr	272,000
Type of humidifier	Electric
Humidifier capacity, lb/hr	22.1
Type of filter	Throwaway
Filter efficiency (ASHRAE Std. 52)	65%

II EAB - Main Area HVAC System.

l. Main Air Handling Unit

There are three 50-percent-capacity supply air handling units, each having the following data:

a. Fan/Coil

Type of fan	Vaneaxial
Fan airflow capacity, scfm	49,630
Fan static pressure capacity, in. wg	12
Fan motor, hp/rpm	190/1,800
Type of heating coil	Electric
Heating coil capacity, maximum, kW	170
Type of cooling coil	Chilled water
Number of cooling coil sets	one
Cooling coil capacity, maximum, Btu/hr	3,000,000

b. Prefilters

Number of cells in set (wide x high)	6 x 4
Each cell airflow capacity, scfm	2,068
Filter efficiency (ASHRAE Std. 52)	80%
Filter pressure drop (dirty), in. wg	0.5

c. High-efficiency filters:

Number of cells in set (wide x high)	6 x 4
Each cell airflow capacity, scfm	2,068
Filter efficiency (ASHRAE Std. 52)	90%
Filter pressure drop (dirty filters), in. wg	1.0

TABLE 9.4-2.1 (Continued)

DESIGN DATA FOR CONTROL ROOM, ELECTRICAL AUXILIARY BUILDING, AND TSC HVAC SYSTEM

2. Return Air Fan

There are three 50-percent-capacity return air fans, each having the following data:

Type of fan	Vaneaxial
Air flow capacity, scfm	45,980
Static pressure capacity, in. wg	6.7
Motor, hp(min/max)/rpm	(60/75)/1,800
Type of drive	Direct

3. Battery Room Exhaust Air Fan

There are three 50-percent exhaust air fans, each having the following data:

Type of fan	Vaneaxial
Air flow capacity, scfm	3,650
Static pressure capacity, in. wg	4
Motor, hp/rpm	5/3,600
Type of drive	Direct

4. Duct Reheat Coils

There are six duct reheat coils for battery rooms and six duct reheat coils for occupied areas and outside air, with the following data:

a. Battery Room duct reheat coils:

Type	Electric, fin tube, explosion-proof
Capacity, kW	7/6/5/9/5*/2*

b. Remaining areas duct reheat coils:

Type	Electric, open coil
Capacity, kW	15/15/5/200/7/3

* Non-Engineered Safety Feature

TABLE 9.4-2.1 (Continued)

DESIGN DATA FOR CONTROL ROOM, ELECTRICAL AUXILIARY BUILDING, AND TSC HVAC SYSTEM

5. Electrical Penetration Area

a. Air-Handling Units

There are two 100-percent-capacity air-handling units for each of the three trains, one for manual operation and the other for emergency operation. The units have the following data:

Train A:	Emergency	Normal
Type of fan	Centrifugal	Centrifugal
Fan air flow capacity, scfm	5,300	2,960
Fan static pressure, in. wg	3.3	3.66
Fan motor, hp/rpm	10/3,600	5/1,800
Type of cooling coil	Chilled Water	
Cooling capacity, Btu/hr	310,000	172,597
Filter:		
Type	None	Throwaway
Efficiency (ASHRAE Std. 52)	--	40%
Pressure drop, in. wg	--	0.5

Train B:	Emergency	Normal
Type of fan	Centrifugal	Centrifugal
Fan air flow capacity, scfm	4,930	3,240
Fan static pressure, in. wg	4.2	3.7
Fan motor, hp/rpm	10/3,600	5/1,800
Type of cooling coil	Chilled Water	
Cooling capacity Btu/hr	272,000	187,289
Filter:		
Type	None	Throwaway
Efficiency (ASHRAE Std. 52)	--	40%
Pressure drop, in. wg	--	0.5

Train C:	Emergency	Normal
Type of fan	Centrifugal	Centrifugal
Fan air flow capacity, scfm	7,100	5,400
Fan static pressure, in. wg	3.9	4.26
Fan motor, hp/rpm	15/1,800	7.5/1,800
Type of cooling coil	Chilled Water	
Cooling capacity, Btu/hr	386,000	313,423

TABLE 9.4-2.1 (Continued)

DESIGN DATA FOR CONTROL ROOM, ELECTRICAL AUXILIARY BUILDING, AND TSC HVAC SYSTEM

5. Electrical Penetration Area (Continued)

a. Air-Handling Units (Continued)

Train C: (Continued)	Emergency	Normal
Filter:		
Type	None	Throwaway
Efficiency (ASHRAE Std. 52)	--	40%
Pressure drop, in. wg	--	0.5

b. Exhaust Fans

There are two 100 percent exhaust fans, each with the following data:

Type of fan	Centrifugal
Air flow capacity, scfm	2,500
Static pressure, in. wg	3.0
Fan motor, hp/rpm	3/1,800
Type of drive	Direct

III. TSC HVAC System

1. Main Air-Handling Unit

There is one 100-percent-capacity air-handling unit with two 100-percent-capacity supply fans.

Type of fan	Centrifugal
Fan air flow, scfm	11,600
Fan static pressure, in. wg	7.0
Fan motor, hp/rpm	25/1,200
Type of heating coil	Electric, fin tube
Heating coil capacity, kW	56
Type of cooling coil	Chilled water
Cooling coil capacity, Btu/hr	485,472

a. Prefilter

Number of cells in set	9
Filter efficiency (ASHRAE Std. 52)	20%
Filter pressure drop (dirty), in. wg	0.5

TABLE 9.4-2.1 (Continued)

DESIGN DATA FOR CONTROL ROOM, ELECTRICAL AUXILIARY BUILDING AND TSC HVAC SYSTEM

1. Main-Air Handling Unit (Continued)

b. High-efficiency filters

Number of cells in set	8
Filter efficiency (ASHRAE Std. 52)	90%
Filter pressure drop (dirty), in. wg	0.5

2. Return Air Fans

There are two 100-percent-capacity return air fans, each with the following data:

Type of fan	Centrifugal
Air flow capacity, scfm	10,500
Static, pressure in. wg	4.89
Fan motor, hp/rpm	15/900
Type of drive	Direct

3. Makeup Air Filter Unit

There is one 100-percent-capacity makeup air unit, sized for 6,100 scfm, consisting of the following components:

a. Prefilters

Number of cells in set	6
Each cell air flow, scfm	1,016
Filter efficiency (ASHRAE Std. 52)	85%
Filter pressure drop (dirty), in. wg	1.0

b. HEPA Filters

There are two sets of HEPA filter banks, one bank upstream and one downstream of the carbon filter. Following is the data for each HEPA filter bank:

Number of cells in set	6
Each cell air flow, scfm	1,016
Filter efficiency (DOP Smoke Test)	99.97%
Filter pressure drop (dirty), in. wg	2.0

TABLE 9.4-2.1 (Continued)

DESIGN DATA FOR CONTROL ROOM, ELECTRICAL AUXILIARY BUILDING, AND TSC HVAC SYSTEM

3. Makeup Air Filter Unit (Continued)

c. Carbon Filter

Number of cells (trays)	18
Each cell airflow capacity, scfm	333
Charcoal bed depth	2 x 2 in.
Filter efficiency for removal of	99%
elemental iodine	99%
methyl iodide	
Filter pressure drop (dirty), in. wg	1.0

d. Electric Heating Coil

Capacity, kW	25
No. of steps	None
Pressure drop, in. wg	0.1

e. Fan

Type	Centrifugal
Air flow capacity, scfm	6,100
Static pressure, in. wg	11.0
Fan motor, hp/rpm	20/3,600
Type of drive	Direct

4. Exhaust Air Fan

There is one 100-percent-capacity exhaust air fan, with the following data:

Type of fan	Centrifugal
Airflow capacity, scfm	660
Static pressure, in. wg	3.5
Fan motor, hp/rpm	3/1,800
Type of drive	Direct

5. TSC Chilled Water System

a. Water Chillers

There are two 100-percent-capacity water chillers each with the following data:

Type	Air-Cooled Scroll
Capacity, tons	95

TABLE 9.4-2.1 (Continued)

DESIGN DATA FOR CONTROL ROOM, ELECTRICAL AUXILIARY BUILDING, AND TSC HVAC SYSTEM

5. TSC Chilled Water System (Continued)

a. Water Chillers (Continued)

Chilled water flow, gal/min	255 (Nominal)
Chilled water supply temp., °F	42 (Nominal)
Refrigerant	R410A
Compressor and condenser fans, kW	116.1

b. Chilled Water Pumps

There are two 100-percent-capacity chilled water pumps, each with the following data:

Type	Centrifugal
Flow capacity, gal/min	255
Pump drive	Direct
Motor, hp/rpm	20/1,800

c. Expansion Tanks

There is one expansion tank common for both chiller trains with the following data:

Tank capacity, gallons	40
Tank design pressure	Atmospheric

d. Chemical Addition Tank

There is one chemical addition tank for both trains, with the following data:

Tank capacity, gallons	10
Tank design pressure, psig	100

e. Air Separator

There is one air separator for both trains.

Air separator design pressure, psig	250

6. Duct Reheat Coils

There are four duct reheat coils with the following data:

Type of coil	Electric, open coil
Capacity, kW	8/4/38/2

TABLE 9.4-2.1 (Continued)

DESIGN DATA FOR CONTROL ROOM, ELECTRICAL AUXILIARY BUILDING, AND TSC HVAC SYSTEM

IV. Essential Chilled Water System

1. Water Chillers

There are three 50-percent-capacity water chiller trains, each with one chiller as follows:

Type	Centrifugal
Capacity, tons	300
Chilled water flow, gal/min	approx. 900
Chilled water supply temp., °F	42**
Condenser water flow, gal/min, maximum	1,100
Condenser water supply temperature, °F	108
Refrigerant	R-11
Compressor, kW	354

**These chillers utilize a duplex temperature/load controller. The controller is set up to operate with a temperature at or slightly below 42°F. The controller acts to maintain the desired temperature while maintaining compressor amperage at or below a controlled limit. If the HVAC load present causes compressor current to exceed the limit, temperature is increased to reduce load. The increase in chilled water temperature both reduces HVAC latent heat loads and increases capacity of the unit (as high as 160%) which reduces compressor current back within limit. The chiller outlet temperature is expected to approach 55°F during post-accident conditions which is an expected response to the latent/sensible heat load from supplementary coolers that operate during these plant conditions.

TABLE 9.4-2.2

DESIGN DATA FOR FUEL-HANDLING BUILDING
HVAC SYSTEM

1. Supply Air Subsystem (see section 9.4.2.2.1)

2. Supplementary Coolers Subsystem

There are three ECCS cubicles (each containing an HHSI pump, an LHSI pump, and a Containment spray pump); three containment sump isolation valve cubicles, two spent fuel pool pump cubicles, and one PASS area.

Each cubicle is provided with one 100-percent-capacity fan cooler having the following data:

a. ECCS Pump Cooler

Cooling capacity of cooler, Btu/hr	815,000
Cooler air flow, ft^3/min	12,700
Number of fans	2
Type of fan	Propeller
Fan motor, hp	5

b. Spent Fuel Pool Pump Cooler

Cooling capacity of cooler, Btu/hr	72,000
Cooler air flow, ft^3/min	1,000
Number of fans	1
Type of fans	Centrifugal
Fan motor, hp	2

c. Containment Sump Isolation Valve Cubicle Cooler

Cooling capacity of cooler, Btu/hr	40,800
Cooler air flow, ft^3/min	540
Number of fans	1
Type of fans	Centrifugal
Fan motor, hp	2

d. PASS Supplementary Cooler

Cooling capacity of cooler, Btu/hr	136,500
Cooler air flow, ft^3/min	3,100
Number of fans	1
Type of fans	Centrifugal
Fan motor, hp	2

TABLE 9.4-2.2 (Continued)

DESIGN DATA FOR FUEL-HANDLING BUILDING HVAC SYSTEM

3. Exhaust Air Subsystem

Total design air flow, ft^3/min	29,000

The system consists of two 100-percent-capacity filter trains, three 50-percent-capacity main exhaust fans, and three 50-percent-capacity exhaust booster fans. Each filter train consists of three 33-1/3-percent-capacity filter units.

Filter Unit

Each filter unit is sized for a nominal 9,667 ft^3/min and consists of the following components:

a. Prefilters

Number of cells in set (wide x high)	4 x 3
Each cell air flow capacity, ft^3/min	806
Filter efficiency	85%
Filter pressure drop (dirty), in. wg	1.0

b. HEPA Filters

Each filter unit has two sets of HEPA filter banks, one bank upstream and one downstream of the carbon filter.

Each HEPA filter bank is as follows:

Number of cells in bank (wide x high)	4 x 3
Each cell air flow capacity, ft^3/min	806
Filter efficiency	99.97%
Filter pressure drop (dirty), in. wg	2.0

c. Carbon Filters

Type	Rechargeable
Filter efficiency for removal of	
elemental iodine (at 70% RH)	95%
methyl iodide (at 70% RH)	95%
Filter pressure drop, in. wg	1.0

TABLE 9.4-2.2 (Continued)

DESIGN DATA FOR FUEL-HANDLING BUILDING
HVAC SYSTEM

d. Electric Heating Coil

Capacity, kW	38
Pressure drop, in. wg	.1

Exhaust Booster Fan

Type	Vaneaxial
Air flow capacity, ft^3/min	14,500 (emergency)
Static pressure capability, in. wg	5.8 (emergency)
Speed, rpm	1,800
Motor, hp	50
Type of discharge	Vertical

Main Exhaust Fan

Type	Centrifugal
Air flow capacity, ft^3/min	14,130 (normal) 14,500 (emergency)
Static pressure capability, in. wg	4.0 (normal) 4.2 (emergency)
Speed, rpm	1,200
Motor, hp	30
Type of discharge	Upblast

TABLE 9.4-2.3

DESIGN DATA FOR MECHANICAL AUXILIARY BUILDING HVAC SYSTEM

I. Main Supply and Exhaust System:

The Main Supply System consists of four 25 percent capacity supply air casings, three 50 percent capacity supply fans and three 50 percent capacity exhaust fans.

1. Supply Air Casings

a. Prefilters

Number of units	4
Air flow per unit, scfm	36,062(U1); 35,700(U2)
Number of cells per unit (wide x high)	10 x 3
Maximum face velocity (ft/min)	600
Filter efficiency (ASHRAE Std. 52)	55%
Filter pressure drop (dirty), in. wg	1

b. Chilled Water Cooling Coils

Number of units	4
Number of sections per unit	6
Type	Finned tube
Air flow, scfm, total	144,250(U1); 142,800(U2)
Water flow, gal/min	3,460
Water temperature in, °F	42
Water temperature out, °F	50.5(U1); 52(U2)
Air inlet, dry bulb/wet bulb, °F	95/81
Air outlet, dry bulb/wet bulb, °F	54/53
Heat removal capacity, Btu/hr	14,700,877(U1); 17,295,000(U2)

c. Heating Coils

Number of units	4 (Not all units required to be in service)
Type	Electric
Air flow rate, scfm, each unit	44,213(U1); 35,700(U2)
kW capacity, each unit	330 Minimum(U1); 325 Minimum (U2)
Number of stages	10
Power Supply, V/phase/Hz	480/3/60
Control power supply, V/phase/Hz	120/1/60

CN-3147

d. Supply Fans

Number of units	3
Type	Centrifugal
Air flow rate, scfm, each fan	72,125(U1); 71,400(U2)
Static pressure capability, in.wg	13.6(U1); 13.8(U2)

TABLE 9.4-2.3 (Continued)

DESIGN DATA FOR MECHANICAL AUXILIARY BUILDING HVAC SYSTEM

1. Supply Air Casings (Continued)

d. Supply fans (Continued)

Motor, hp (nominal)	250
Type of discharge	Horizontal

e. Exhaust Fans

Number of units	3
Type	Vaneaxial
Air flow rate, scfm, each fan	96,375
Total pressure, in. wg	11.2
Motor, hp (nominal)	250
Type of discharge	Horizontal

II. Supplementary Cubicle Coolers Subsystem

There are 21 units, each serving a pump area or a cubicle. The CCW pumps are served with coolers using ECW, the charging pumps with coolers using CCW, the Radwaste Counting Room with TSC chilled water, and the remaining coolers are served by Essential Chilled Water.

1. Component Cooling Water Pump Cubicle Coolers (three units)

Cabinet arrangement	Draw-through
Cooling load, Btu/hr, each	169,000
Air flow, scfm, each	23,000
Water inlet temperature, °F	108
Water leaving temperature, °F	118
Type of fan	Propeller
Number of fans per cooler	3
Each fan motor, hp (nominal)	3

2. Centrifugal Charging Pump Cubicle Coolers (two units)

Cabinet arrangement	Draw-through
Cooling load, Btu/hr, each	133,000
Air flow, scfm, each	16,000
Water inlet temperature, °F	118
Water leaving temperature, °F	125
Type of fan	Propeller
Number of fans per cooler	2
Each fan motor, hp (nominal)	5

TABLE 9.4-2.3 (Continued)

DESIGN DATA FOR MECHANICAL AUXILIARY BUILDING
HVAC SYSTEM

II. Supplementary Cubicle Coolers Subsystem (Continued)

3. Positive Displacement Charging Pump Cubicle Cooler (one unit)

Cabinet arrangement	Draw-through
Cooling load, Btu/hr, each	37,000
Air flow, scfm, each	4,900
Water inlet temperature, °F	118
Water leaving temperature, °F	123
Type of fan	Propeller
Number of fans per cooler	1
Each fan motor, hp (nominal)	5

4. EAB Chiller Rooms Cubicle Cooler (three units)

Cabinet arrangement	Draw-through
Cooling load, Btu/hr, each	198,940
Air flow, scfm, each	3,070
Type of fan	Centrifugal
Number of fans per cooler	1
Each fan motor, hp (nominal)	5
Type of coil	Chilled Water

5. Boric Acid Transfer Pump Room Cubicle Cooler (two units)

Cabinet arrangement	Draw-through
Cooling load, Btu/hr, each	49,800
Air flow, scfm, each	730
Type of fan	Centrigual
Number of fans per cooler	1
Each fan motor, hp (nominal)	1
Type of coil	Chilled Water

6. Centrifugal Charging Pump Valve Rooms Cubicle Cooler (three units)

	(One unit)	(Two units)
Cabinet arrangement	Draw- through	Draw-through
Cooling load, Btu/hr, each	15,800	10,850
Air flow, scfm, each	250	250
Type of fan	Centrifugal	Centrifugal
Number of fans per cooler	1	1
Each fan motor, hp (nominal)	1	1
Type of coil	Chilled Water	Chilled Water

TABLE 9.4-2.3 (Continued)

DESIGN DATA FOR MECHANICAL AUXILIARY BUILDING HVAC SYSTEM

II. Supplementary Cubicle Coolers Subsystem (Continued)

7. Reactor Make-Up Water Pump Room Cubicle Cooler (two units)

Cabinet arrangement	Draw-through
Cooling load, Btu/hr, each	85,000
Air flow, scfm, each	1,550
Water inlet temperature, °F	42
Water leaving temperature, °F	52
Type of fan	Centrifugal
Number of fans per cooler	1
Each fan motor, hp (nominal)	2

8. Radwaste Control Room Cubicle Cooler (two units) - These units have been spared and abandoned-in-place.

Cabinet arrangement	Draw-through
Cooling load, Btu/hr, each	243,000
Air flow, scfm, each	11,270
Water inlet temperature, °F	42
Water leaving temperature, °F	52
Type of fan	Centrifugal
Number of fans per cooler	1
Each fan motor, hp (nominal)	15

9. Radiation Monitor Room Cubicle Cooler (two units)

Cabinet arrangement	Draw-through
Cooling load, Btu/hr, each	105,000
Air flow, scfm, each	2,140
Water inlet temperature, °F	42
Water leaving temperature, °F	52
Type of fan	Centrifugal
Number of fans per cooler	1
Each fan motor, hp (nominal)	5

10. Volume Control Tank Valve Room Cubicle Coolers (two units)

Cabinet arrangement	Draw-through
Cooling load, Btu/hr, each	15,800
Air flow, scfm, each	250
Water inlet temperature, °F	42
Water leaving temperature, °F	54
Type of fan	Centrifugal
Number of fans per cooler	1
Each fan motor, hp (nominal)	1

TABLE 9.4-2.3 (Continued)

DESIGN DATA FOR MECHANICAL AUXILIARY BUILDING
HVAC SYSTEM

II. Supplementary Cubicle Coolers Subsystem (Continued)

11. Radwaste Counting Room Cooler (one unit)

Cabinet arrangement	Draw-through
Cooling load, Btu/hr, each	102,400
Air flow, scfm, each	2,880
Type of fan	Centrifugal
Number of fan per cooler	1
Each fan motor, hp (nominal)	5
Type of coil	Chilled Water
Pre-filter efficiency (ASHRAE Std. 52)	30%
HEPA Filter Efficiency	99.97%

III. Supplementary Supply and Exhaust Subsystem

The Supplementary Supply System consists of one air-handling unit, two 100-percent-capacity supply fans, and duct-mounted heating coils.

1. Filter Plenum

a. High Efficiency Filters

Number of units	1
Air flow per unit, scfm	22,100
Number of cells per unit (wide x high)	4 x 3
Maximum face velocity (ft/min)	600
Filter efficiency (ASHRAE Std 52)	90%
Filter pressure drop (dirty), in. wg	1

b. Heating Coils

Number of units	1
Type	Electric
Air flow, scfm	22,100
kW capacity	176
Number of stages	6
Power supply, V/phase/Hz	480/3/60
Control power supply, V/phase/Hz	120/1/60

c. Chilled Water Cooling Coils

Number of units	1
Type	Finned-tube
Air flow, scfm	22,100
Water flow, gal/min	540
Water temperature in, °F	42
Water temperature out, °F	52

TABLE 9.4-2.3 (Continued)

DESIGN DATA FOR MECHANICAL AUXILIARY BUILDING
HVAC SYSTEM

1. Filter Plenum (Continued)

c. Chilled Water Cooling Coils (Continued)

Air inlet, dry bulb/wet bulb, °F	104/81
Air outlet, dry bulb/wet bulb, °F	53/52
Heat removal capacity, Btu/hr	2,546,000

2. Supply Fans

Cabinet arrangement	Blow-through
Number of units	2
Type	Vaneaxial
Air flow rate, scfm, each	22,100
Static pressure, in. wg	9.8
Motor, hp (nominal)	100
Type of discharge	Horizontal

3. Duct-Mounted Heating Coils

Duct-Mounted Heating Coils	007	009	010	011	015
Number of units	1	1	1	1	1
Type			Electric		
Air flow, scfm	7,550	4,550	1,600	2,120	5,070
kW capacity	50	35	15	15	45
Number of stages	6	6	5	6	6
Power supply, V/phase/Hz			480/3/60		
Control power supply, V/phase/Hz			120/1/60		

This subsystem consists of two filter units, one for the sampling room and one for the radiochemical laboratory and two 100-percent-capacity exhaust fans.

4. Sample Room Filter Unit

a. Prefilter

Air flow, scfm	1,570
Number of cells (wide x high)	1 x 2
Nominal air flow per cell	785 ft³/min
Filter efficiency	85% (std 52)
Filter pressure drop (dirty), in. wg	1.0

TABLE 9.4-2.3 (Continued)

DESIGN DATA FOR MECHANICAL AUXILIARY BUILDING
HVAC SYSTEM

4. Sample Room Filter Unit (Continued)

a. HEPA Filter (Two banks, one bank located upstream and one bank downstream of the carbon filters) (Continued)

Air flow, scfm	1,570
Number of cells	1 x 2
Charcoal bed depth	785 ft³/min
Filter efficiency for removal of methyl iodide	99.97%
Filter pressure drop, in. wg	2.0

b. Carbon Filters

Air flow, scfm	1,570
Number of cells	6
Charcoal bed depth	2 in.
Filter efficiency for removal of methyl iodide	95%
Filter pressure drop, in. wg	1.0

5. Radiochemical Laboratory Filter Unit

a. Prefilter

Air flow	3,430
Number of cells (wide x high)	1 x 3
Nominal air flow per cell, scfm	1143 ft³/min
Filter efficiency	85% (Std 52)
Filter pressure drop (dirty), in. wg	1.0

b. HEPA Filter (Two banks, one bank located upstream and one bank downstream of the carbon filters)

Air flow, scfm	3,430
Number of cells (wide x high)	1 x 3
Nominal air flow per cell, scfm	1143 ft³/min
Filter efficiency (dioctyl phthalate test)	99.97%
Filter pressure drop (dirty), in. wg	2.0

TABLE 9.4-2.3 (Continued)

DESIGN DATA FOR MECHANICAL AUXILIARY BUILDING
HVAC SYSTEM

5. Radiochemical Laboratory Filter Unit (Continued)

c. Carbon Filters

Air flow, scfm	3,430
Number of cells	9
Charcoal bed depth	2 in.
Filter efficiency for removal of methyl iodide	95%
Filter pressure drop, in. wg	1.0

6. Supplementary Exhaust Fans

Number of units	2
Type	Centrifugal
Air flow rate, scfm, each	5,000
Speed, rpm	3,550
Motor, hp	25

IV. MAB Chilled Water System

1. Water Chillers

There are three in Unit 1 and four in Unit 2 one-third-capacity water chillers, each with the following data:

Type	Centrifugal
Capacity, tons	550
Chilled water flow, gal/min	1,560
Chilled water supply temperature, °F	42*
Condenser water flow, gal/min	2,000
Condenser water temperature in, °F	95
Compressor/motor power input, Kw	536

2. Chilled Water Pumps

There are four 33-1/3-percent-capacity chilled water pumps, each with the following data:

Type	Centrifugal
Flow capacity, gal/min	1,560
Total dynamic head, ft	305
Power supply, V/phase/Hz	480/3/60
Motor, hp	200

* These chillers utilize a duplex temperature/load controller. The controller acts to maintain the desired temperature (see UFSAR text) while maintaining compressor amperage at or below the controlled limit. If the HVAC load present causes compressor current to exceed the limit, temperature is increased to reduce load. The increase in chilled water temperature both reduces HVAC latent heat load and increases capacity of the unit (as high as 160%) which reduces compressor current back within limit.

TABLE 9.4-2.3 (Continued)
DESIGN DATA FOR MECHANICAL AUXILIARY BUILDING
HVAC SYSTEM

3. Expansion Tank

There is one expansion tank for the MAB chilled water system, with the following data:

Tank capacity, gallons	70
Design pressure, psig	50

4. Air Separator

There is one air separator for the MAB chilled water system, with the following data:

Design Pressure, psig	250
Size	36 in. dia x 66-1/2 in. high

5. Chemical Addition Tank

There is one air chemical addition tank for both MAB and RCB chilled water systems with the following data:

Tank capacity, gallons	10
Design Pressure, psig	100

TABLE 9.4-2.4

DESIGN DATA FOR TURBINE-GENERATOR BUILDING HVAC SYSTEM

I. VENTILATION SUBSYSTEM

The Ventilation Subsystem consists of the following:

1. Supply Fans

Number of fans	11	4
Type	Vaneaxial	Vaneaxial
Capacity per fan, ft^3/min	57,000	57,000
Static pressure capability, in. wg	2.4	2.0
Speed, rpm	1,200	1,200
Motor, hp	40	30
Type of discharge	Horizontal except for 3 fans which are vertical discharge	Horizontal

2. Transfer Fans

Number of fans	6	2
Type	Propeller	Propeller
Capacity per fan, ft^3/min	50,000	7,000
Static pressure capability, in. wg	0.5	0.75
Speed, rpm	900	l,200
Motor, hp	l5	l.5
Type of discharge	Horizontal	Horizontal

3. Exhaust Fan

Number of fans	2
Type	Vaneaxial
Capacity per fan, ft^3/min	32,040
Static pressure capability, in. wg	1.6
Speed, rpm	1,200
Motor, hp	25
Type of discharge	Vertical

4. Unit Heaters

Number of units	54
Capacity per unit, kW	10

TABLE 9.4-2.4 (Continued)

DESIGN DATA FOR TURBINE-GENERATOR BUILDING
HVAC SYSTEM

II. SUPPLEMENTARY HVAC SUBSYSTEM

1. Cold Chemistry Lab Area HVAC Subsystem

a. Air-Conditioning Unit

Number of units	1
Type of units	Draw-through/Direct Drive
Filter type	Throwaway
Air flow, ft^3/min	14,000
Static pressure capability, in wg.	2.0
Speed, rpm	1,800
Motor, hp	20
Air-conditioning unit type	Direct expansion
Cooling capacity, Btu/hr	474,840
Refrigerant type	R-22

b. Duct Heaters

Quantity	3
Type	Electric
Heating capacity, kW	60/15/10

c. Toilet Exhaust Fan

Number of fans	1
Type	Centrifugal
Capacity, ft^3/min	650
Static pressure capability, in. wg	0.75
Speed, rpm	1,800
Motor, hp	0.25
Type of discharge	N/A

2. Battery Room HVAC Subsystem

a. Split-Type Air-Conditioning Unit

Air-Cooled Condensing Unit

Number of units	1
Cooling capacity, Btu/hr	277,500

TABLE 9.4-2.4 (Continued)

DESIGN DATA FOR TURBINE-GENERATOR BUILDING HVAC SYSTEM

2. Battery Room HVAC Subsystem (Continued)

a. Split-Type Air-Conditioning Unit (Continued)

Air-Handling Unit

Number of units	1
Cooling capacity of evaporator, Btu/hr	277,500
Air flow rate, ft^3/min	3,600
Speed, rpm	1,800
Motor, hp	3

b. Duct Heaters

Heating capacity, kW(Battery Room)	30
Heating capacity, kW(Battery Charger Room)	7.5

c. Exhaust Fans

Number of fans	2 (100% capacity)
Type	Vaneaxial
Capacity per fan, ft^3/min	1,800
Static pressure capability, in. wg	0.5
Speed, rpm	1,200
Motor, hp	1.0

3. Emergency Diesel Generator Room Ventilation Subsystem

a. Exhaust Fan

Number of fans	1
Type	Propeller
Capacity per fan, ft^3/min	2,500
Static pressure capability, in. wg	0.75
Speed, rpm	1,200
Motor, hp	0.75

b. Unit Heater

Number of units	1
Capacity, kW	10

TABLE 9.4-2.4 (Continued)

DESIGN DATA FOR TURBINE-GENERATOR BUILDING
HVAC SYSTEM

4. 13.8 kV Switchgear Room and Cable Vault Ventilation Subsystem

a. Supply Fans

Number of fans	2 (50% capacity)
Type	Vaneaxial
Capacity per fan, ft³/min	31,000
Static pressure capability, in. wg	1.5
Speed, rpm	1,200
Motor, hp	20

b. Prefilters

Number of units	2
Type	Throwaway
Air flow, scfm	31,000
Efficiency	40%

c. Unit Heater

	8
Number of units	10
Capacity, kW	

5. 4.16 kV Switchgear Room Ventilation Subsystem

a. Supply Fans

Number of fans	2 (50% capacity)
Type	Vaneaxial
Capacity per fan, ft³/min	7,750
Static pressure capability, in. wg	1.0
Speed, rpm	1,200
Motor, hp	3

b. Prefilters

Number of units	2
Type	Throwaway
Air flow, scfm	7,750
Efficiency	40%

c. Unit Heater

Number of units	2
Capacity, kW	10

TABLE 9.4-2.4 (Continued)

DESIGN DATA FOR TURBINE-GENERATOR BUILDING
HVAC SYSTEM

6. Excitation Room HVAC Subsystem

Air-Conditioning Units

Number of units	2
Type of unit	Window type
Cooling capacity per unit, Btu/hr	1 with 12,000 1 with 18,000

7. Elevator Machine Room Ventilation Subsystem

Number of machine rooms	2

a. Exhaust Fan

Number of fans per machine room	1
Type	Centrifugal
Capacity per fan, ft^3/min	6,570
Static pressure capability, in. wg	0.5
Speed, rpm	1,800
Motor, hp	1

b. Unit Heaters

Number of units per machine room	1
Capacity per unit, kW	10

TABLE 9.4-2.4 (Continued)

DESIGN DATA FOR TURBINE-GENERATOR BUILDING
HVAC SYSTEM

8. Operator Room HVAC Subsystem

a. Air-Conditioning Unit

Number of units	1
Type of unit	Packaged, with heat

b. Toilet exhaust fan

Number of units	1
Type	Centrifugal

9. Electro-Hydraulic Cabinet Enclosure HVAC Subsystem

a. Air-Conditioning Units

Number of units	2 (one acts as spare)
Type of unit	Window type
Cooling capacity per unit, Btu/hr	30,000

TABLE 9.4-2.5

DESIGN DATA FOR THE REACTOR CONTAINMENT HVAC SYSTEM

1. Reactor Containment Fan Cooler Subsystem

   Detailed RCFC Design Data are presented in Table 6.2.2-2

2. Containment Cubicles Exhaust Subsystem

   This subsystem consists of two 50-percent-capacity trains and each train consists of two 100-percent-capacity fans.

Type	Vaneaxial
Air flow, scfm	9,300
Static pressure in. wg.	2.5
Speed, rpm	1,800
Motor, hp (nominal)	7.5
Type of discharge	Vertical

3. Containment Carbon Unit Subsystem

   This subsystem consists of two 50-percent-capacity filter units, each with two l00 percent capacity fans.

   a. Prefilters

Number of units	2
Air flow, scfm	10,000
Number of cells (wide x high)	3 x 3
Nominal air flow capacity per cell, scfm	1,000
Filter efficiency,	85%
Filter pressure drop (dirty), in. wg	1.0

   b. HEPA filters (two banks, one upstream and one downstream of carbon adsorber)

Number of units	2
Air flow, scfm	10,000
Number of cells (wide x high)	3 x 3
Nominal air flow capacity per cell, scfm	1,000
Filter efficiency (dioctyl phthalate test)	99.97%
Filter pressure drop (dirty), in. wg	2.0

TABLE 9.4-2.5 (Continued)

DESIGN DATA FOR THE REACTOR CONTAINMENT
HVAC SYSTEM

3. Containment Carbon Unit Subsystem (Continued)

c. Carbon Adsorber

Number of units	2
Air flow, scfm	10,000
Type	Gasketless
Charcoal bed depth, in.	2
Filter efficiency for removal of	
elemental iodine	95%
methyl iodine	95%
Filter pressure drop at design flow, in. wg	1.0

d. Fans

Number of units	4
Type	Centrifugal
Air flow, scfm	10,000
Static pressure, in. wg	8.0
Speed, rpm	1,800
Motor, hp (nominal)	20
Type of discharge	Horizontal

4. Control Rod Drive Mechanism Ventilation Subsystem

The CRDM Ventilation Subsystem is provided by Westinghouse. This subsystem consists of three 50-percent-capacity fans.

Type	Centrifugal
Air flow, scfm	20,000
Static pressure, in. wg	6
Speed, rpm	1,800
Motor, hp (nominal)	40
Type of discharge	Vertical

5. Reactor Cavity and Support Ventilation Subsystem

This subsystem consists of two 100 percent supply fans and two 100-percent-capacity exhaust fans.

a. Supply Fans

Type	Centrifugal
Air flow, scfm	26,000
Static pressure, in. wg	5.0
Speed, rpm	1,200
Motor, hp (nominal)	40
Type of discharge	Vertical

TABLE 9.4-2.5 (Continued)

DESIGN DATA FOR THE REACTOR CONTAINMENT
HVAC SYSTEM

b. Exhaust Fans

Number of units	2
Type	Vanaxial
Air flow, scfm	6,240
Static pressure, in. wg	3.5
Speed, rpm	3,600
Motor, hp (nominal)	20
Type of discharge	Horizontal

6. Normal Containment Purge Subsystem

This subsystem is subdivided into a supply and an exhaust portion. The supply portion consists of one l00 percent filter train and two 100 percent capacity supply fans. The exhaust portion consists of two 100 percent capacity fans.

a. Supply

1) Prefilters

Number of units	1
Air flow, scfm	40,000
Number of cells (wide x high)	7 x 3
Nominal air flow capacity per cell, scfm	2,000
Filter efficiency	55%
Filter pressure drop (dirty), in. wg	1.0

2) High-efficiency filters

Number of units	1
Air flow, scfm	40,000
Number of cells per unit (wide x high)	7 x 3
Nominal air flow capacity per cell, scfm	2,000
Filter efficiency	95%
Filter pressure drop (dirty), in. wg	1.5

3) Heating coils

Number of units	2
Type	Electric
Air flow, scfm	40,000
kW capacity	255.5
Number of stages	8
Power supply, V/phase/Hz	480/3/60

TABLE 9.4-2.5 (Continued)

DESIGN DATA FOR THE REACTOR CONTAINMENT
HVAC SYSTEM

4) Supply fans

Number of units	2
Type	Vaneaxial
Air flow, scfm	40,000
Static pressure, in. wg	12
Speed, rpm	1,800
Motor, hp (nominal)	125
Type of discharge	Horizontal

b. Exhaust

Exhaust fans

Number of units	2
Type	Vaneaxial
Air flow, scfm	40,000
Static pressure, in. wg	5.0
Speed, rpm	1,800
Motor, hp (nominal)	60
Type of discharge	Horizontal

7. Supplementary Containment Purge Subsystem

The subsystem is subdivided into a supply and an exhaust portion.

a. Supply

1) Prefilters

Number of units	1
Air flow, scfm	4,500
Number of cells (wide x high)	2 x 2
Nominal air flow capacity per cell, scfm	2,000
Filter efficiency	55%
Filter pressure drop (dirty), in. wg	1.0

2) High-efficiency filters

Number of units	1
Air flow, scfm	4,500
Number of cells per unit (wide x high)	2 x 2
Nominal air flow capacity per cell, scfm	2,000
Filter efficiency	95%
Filter pressure drop (dirty), in. wg	1.5

3) Heating coils

Number of units	1
Type	Electric
Air flow, scfm	4,500
kW capacity	90
Number of stages	8
Power supply, V/phase/Hz	480/3/60

TABLE 9.4-2.5 (Continued)

DESIGN DATA FOR THE REACTOR CONTAINMENT HVAC SYSTEM

4) Supply fans

Number of units	2
Type	Centrifugal
Air flow, scfm, Capacity	5,000
Air flow, scfm, Normal Flow	4,500
Static pressure, in. wg	9.0
Speed, rpm	1,800
Motor, hp (nominal)	20.0
Type of discharge	Vertical

b. Exhaust

1) Exhaust fans

Number of units	2
Type	Centrifugal
Air flow, scfm, Capacity	5,000
Air flow, scfm, Normal Flow	4,500
Static pressure, in. wg	8.0
Speed, rpm	1,800
Motor, hp (nominal)	20
Type of discharge	Vertical

2) Prefilters

Number of units	1
Air flow, scfm	4,500
Number of cells (wide x high)	2 x 2
Nominal air flow capacity per cell, scfm	2,000
Filter efficiency	≥55%
Filter pressure drop (dirty), in. wg	1.0

3) HEPA filters

Number of units	1
Air flow, scfm	4,500
Number of cells per unit (wide x high)	2 x 2
Nominal air flow capacity per cell, scfm	2,000
Filter efficiency (dioctyl phthalate)	99.97%
Filter pressure drop (dirty), in. wg	2.0

8. Tendon Gallery Tunnel Ventilation Subsystem

This subsystem consists of two 50-percent-capacity exhaust fans.

Type	Vaneaxial
Air flow, scfm	500
Total pressure, in. wg	1.0
Speed, rpm	1,800
Motor, hp (nominal)	1.0
Type of discharge	Vertical

TABLE 9.4-2.5 (Continued)

DESIGN DATA FOR THE REACTOR CONTAINMENT

HVAC SYSTEM

9. Elevator Machine Room Ventilation Subsystem

Number of units	1
Type	Centrifugal
Air flow, scfm	6,570
Static pressure, in. wg	0.5
Speed, rpm	520
Motor, hp (nominal)	1.0

10. Reactor Containment Chilled Water System

This system consists of three 50-percent-capacity water chillers, three 50-percent-capacity chilled water pumps, one expansion tank, and one air separator.

a. Water Chillers

Type	Centrifugal
Capacity, tons	500
Chilled water flow, gal/min	1,090
Chilled water supply temperature, °F	45*
Condenser water flow, gal/min	2,000
Condenser water temperature in, °F	95
Refrigerant	R-11
Compressor motor, kW	510
Power supply, V/phase/Hz	4,160/3/60

b. Chilled Water Pumps

Type	Centrifugal
Flow discharge, gal/min	1100
Total dynamic head, ft	180
Speed, rpm	1,800
Pump drive, type	Direct
Motor, hp (nominal)	100
Power supply, V/phase/Hz	460/3/60

c. Expansion Tank

Tank capacity, gallons	70
Design pressure, psig	50

d. Air Separator

Size	24 in. dia x 51-1/2 in. high
Design pressure, psig	250

*These chillers utilize a duplex temperature/load controller. The controller acts to maintain the desired temperature (see UFSAR text) while maintaining compressor amperage at or below the controlled limit. If the HVAC load present causes compressor current to exceed the limit, temperature is increased to reduce load. The increase in chilled water temperature both reduces HVAC latent heat load and increases capacity of the unit (as high as 160%) which reduces compressor current back within limit.

TABLE 9.4-2.6

DESIGN DATA FOR DIESEL GENERATOR BUILDING HEATING AND VENTILATING SYSTEM

1. DGB Normal Heating and Ventilating Subsystem

The DGB Normal Heating and Ventilating Subsystem consists of three 100- percent-capacity equipment trains (one per DG train)

a. Filter

Number of units	3
Air flow, scfm	16,600
Nominal air flow capacity, scfm	16,600
Filter efficiency (ASHRAE Std. 52)	40%
Filter pressure drop (dirty filters), in. wg	0.5

b. Supply Fans

Number of units	3
Type	Vaneaxial
Capacity per fan, scfm	16,600
Static pressure, in. wg	1.78
Motor, hp/rpm	15/1,200
Type of drive	Direct

c. Electric Unit Heaters

Total number of units	18
Number of Units per train	6
Type	Horizontal discharge (motor explosion-proof)
Capacity, kW	4 units at 10 kW each 2 units at 15 kW each

d. Fuel Oil Storage Tank Room Exhaust Fans

Total number of units	3
Type	Centrifugal
Capacity per fan, scfm	1,500
Static pressure, in. wg	1.0
Motor, hp/rpm	1.5/1,160
Type of drive	Belt

Table 9.4-2.6 (Continued)

DESIGN DATA FOR DIESEL GENERATOR BUILDING
HEATING AND VENTILATING SYSTEM

2. DGB Emergency Ventilation Subsystem

The DGB Emergency Ventilation Subsystem consists of three 100-percent- capacity supply fans (one per DG train)

Number of units	3
Type	Vaneaxial
Capacity per fan, scfm	123,000
Static pressure, in. wg	1.5
Motor, hp/rpm	75/900
Type of drive	Direct

TABLE 9.4-2.7

DESIGN DATA FOR MISCELLANEOUS BUILDING HVAC SYSTEM

l. ECWIS Ventilation Subsystem

a. Ventilation Fan

There are three 50-percent-capacity pump cubicles and each consists of:

Type	Propeller
Number of fans	2 (50% capacity)
Air flow per fan, scfm	10,000
Static pressure, in. wg	1.0
Speed, rpm	1,800
Motor, hp	7.5
Type of discharge	Horizontal

b. Unit heaters (per train)

Pump bays	3 per bay
Screen wash rooms	1 per room

TABLE 9.4-2.8

DESIGN DATA FOR MSIV BUILDING
VENTILATION SYSTEM

1. MSIVC Ventilation Subsystem

One 100-percent-capacity fan for each of three electric-motor-driven auxiliary feedwater pumps and valve cubicles

Type	Vaneaxial
Air flow, scfm	26,000
Static pressure, in. wg	2.04
Speed, rpm	1,200
Motor, hp	20
Type of drive	Direct

One 100-percent-capacity fan for steam-driven auxiliary feedwater pump and valve cubicle

Type	Vaneaxial
Air flow, scfm	20,000
Static pressure, in. wg	2.0
Speed, rpm	1,200
Motor, hp	15
Type of drive	Direct

2. Pipe Restraint Area and Containment Penetrations Ventilation Subsystem

Two 100-percent-capacity fans for each of four pipe restraints and penetrations areas

Type	Vaneaxial
Air flow, scfm	9,500
Static pressure, in. wg	2.5
Speed, rpm	1,800
Motor, hp	10
Type of drive	Direct

3 MSIVC Heating Subsystem

Two 50-percent-capacity unit heaters in each valve cubicle, and one 100- percent-capacity unit heat in each pump room.

Type	Electric
Number of units	3 per train
Capacity (per train)	2 x 10 kW 1 x 5 kW

TABLE 9.4-3

PLANT MAIN EXHAUST DUCT DATA

Height	131 ft, 0 in
Base elevation	Same as Mechanical Auxiliary Building roof, El. 95 ft, 0 in.
Size	76 in. x 144 in.
Exit velocity	3822 ft/min
Maximum effluent temperature	120°F
Design ambient temperature (based on Bay City, Texas)	Summer: 95°F db, 81°F wb Winter: 29°F db

TABLE 9.4-4

FILTER PERFORMANCE DATA AND
TESTS ACCEPTANCE CRITERIA

1. HEPA Filters

The HEPA filter performance is in accordance with the Institute of Environmental Science CS-1 and CS-8. The in-place testing is in accordance with ANSI N510-1980, "Testing of Nuclear Air Cleaning Systems".

There are three locations in each unit where HEPA filters were installed in non-nuclear applications: RCB Supplemental Purge Exhaust, Radioactive Vent Header, and Radwaste Counting Room Cooler . These installations were to limit migration of particulate to the unit vent and are not required for any safety related function; nor was the application required to credit dose calculations. ANSI N510-1980 does not apply.

2. Iodine Removal Carbon Filters

The performance of the iodine-removal carbon filters is in accordance with the RDT standard of "Gas-Phase Adsorbents for Trapping Radioactive Iodine and Iodine Compound", RDT M16-IT.

The in-place testing is in accordance with ANSI Standard N510-1980.

TABLE 9.4-5.1

CONTROL ROOM & ELECTRICAL AUXILIARY BUILDING HVAC
FAILURE MODES AND EFFECTS ANALYSIS

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Safety Function Capability	General Remarks
Control Room						
Makeup air intake radiation monitors (typical)	Provide a signal for emergency mode operation of the HVAC	1-6	One monitor fails	CRT display and alarm	None – A redundant radiation monitor is provided	
Makeup filters inlet dampers (typical) DA227, DA228, DA229	Open and allow flow to the filters	1-6	One damper fails to open	Position indication ESF status monitoring	None – Loss of one 50% filter train leaves a 100% capacity for makeup air via the 2 remaining 50% trains	
Makeup unit fans (typical)	Operate and supply flow to the filter units	1-6	The fan fails to provide adequate flow	Status indication ESF status monitoring	(See above)	
Makeup unit heaters (typical)	Operate and provide heating to maintain the relative humidity below 70%	1-6	Fails to energize	High moisture alarm	None – Loss of one 50% filter train leaves a 100% capacity for makeup air via the 2 remaining 50% trains	
					No credit is taken in the accident analysis for makeup air filtration.	

* Plant Modes

1. Power Operation	4. Hot Shutdown
2. Startup	5. Cold Shutdown
3. Hot Standby	6. Refueling

TABLE 9.4-5.1 (Continued)

CONTROL ROOM & ELECTRICAL AUXILIARY BUILDING HVAC
FAILURE MODES AND EFFECTS ANALYSIS

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Safety Function Capability	General Remarks
Makeup Unit discharge damper DA230, DA231, DA232 (typical)	Open and modulate for constant flow	1-6	One damper fails to open or provide adequate flow	Lo/Hi flow alarm Position indication	(See above) None – Loss of one 50% filter train due to a damper failing shut leaves a 100% capacity for makeup air via the two remaining 50% trains.	
Supply AHU outside air isolation damper(s) (typical) DA240, DA241, DA242, DA243, DA244, DA245	Isolate control room HVAC	1-6	One damper fails to close	Position indication ESF status monitoring	None – The redundant dampers in series will isolate	

.

* Plant Modes
1. Power Operation
2. Startup
3. Hot Standby
4. Hot Shutdown
5. Cold Shutdown
6. Refueling

TABLE 9.4-5.1 (Continued)

CONTROL ROOM & ELECTRICAL AUXILIARY BUILDING HVAC
FAILURE MODES AND EFFECTS ANALYSIS

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Safety Function Capability	General Remarks
Supply AHU cooling coil (typical)	Operate and provide cooling for the control room	1-6	One fails to provide adequate cooling	Temperature Hi/Lo alarm	None – The two remaining 50% HVAC trains will supply 100% of the required conditioned air	
Supply AHU fans (typical)	Operate and provide flow to the control room	1-6	One fan fails to provide adequate flow	Status indication ESF status monitoring	(See above)	
Return air fans (typical)	Operate and provide return air flow	1-6	One fan fails to provide adequate flow	Status indication ESF status monitoring	(See above)	
Emer. Cond. CR AHU Inlet Dampers: DA249 DA250, DA251	To close partly and allow a small amount of bypass flow	1-6	One damper fails to close partly	Position indication ESF status monitoring	None – The loss of one 50% train will still leave 100% capacity available	
Smoke Purge Return Dampers: DA281, DA282, DA283	To stay open and allow flow to the supply AHU	1-6	One damper closes	Position indication ESF status monitoring	(See above) Note: Failure of smoke purge exhaust damper in the open position during emergency mode is not considered in the FMEA (Ref. IOM# 34396).	
Emer. Clean-up Filter Dampers: DA258, DA259, DA260	To open and allow flow to pass thru the carbon filter train	1-6	One damper fails to open	Position indication ESF status monitoring	(See above)	
Clean up unit fans (typical)	Operate and provide flow thru the carbon units	1-6	One fan fails to provide adequate flow	Status indication ESF status monitoring	(See above)	

* Plant Modes
1. Power Operation
2. Startup
3. Hot Standby
4. Hot Shutdown
5. Cold Shutdown
6. Refueling

TABLE 9.4-5.1 (Continued)

CONTROL ROOM & ELECTRICAL AUXILIARY BUILDING HVAC
FAILURE MODES AND EFFECTS ANALYSIS

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Safety Function Capability	General Remarks
Duct reheat coils (typical) (i.e., room heaters)	None	1-6	One heater fails to deenergize by ESF signal	ESF status monitoring	None - Temperature control will act as a backup Should the main control room heater inadvertently energize, manual action will be initiated in 30 minutes to deenergize the heater thereby reducing the control room temperature. Peak temperature will not affect the operability of control room equipment.	
Toilet/kitchen exhaust dampers DA267, DA268 (typical)	To close and isolate	1-6	One damper fails to close	Position indication ESF status monitoring	None - The damper in series will close	
Toilet/kitchen exhaust fan	To stop running	1-6	Fails to deenergize	Status indication	None - The isolation dampers will have closed	
Backdraft dampers (typical)	Open and allow flow	1-6	One fails to open	None	None - The other redundant trains will supply adequate capacity	

* Plant Modes

1. Power Operation	4. Hot Shutdown
2. Startup	5. Cold Shutdown
3. Hot Standby	6. Refueling

TABLE 9.4-5.1 (Continued)

CONTROL ROOM & ELECTRICAL AUXILIARY BUILDING HVAC
FAILURE MODES AND EFFECTS ANALYSIS

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Safety Function Capability	General Remarks
DC power source (Channels I, III, IV)	Provide DC power	1-6	Lose one DC channel	ESF status monitoring DC trouble alarm	None - All components fail in their safe emergency state	
Essential Chilled Water pumps (typical)	Operate and deliver cooling water	1-6	One pump fails to provide adequate flow	Status indication ESF status monitoring	None - Each train is 50% thus loss of one train will leave 100% capacity	
Essential Chillers 300 ton	Operate and provide chilled water	1-6	One chiller fails to provide adequate cooling	Chiller trouble alarm ESF monitoring	Failure of one 300-ton chiller would result in loss of the affected train The two remaining trains, each with 300-ton chiller, will meet all system safety function requirements	
Main Flow Control Valves (typical)	To open fully and allow flow	1-6	One fails to open and provide adequate flow	Position indication ESF status monitoring	(See above)	

* Plant Modes

1. Power Operation
2. Startup
3. Hot Standby
4. Hot Shutdown
5. Cold Shutdown
6. Refueling

TABLE 9.4-5.1 (Continued)

CONTROL ROOM & ELECTRICAL AUXILIARY BUILDING HVAC
FAILURE MODES AND EFFECTS ANALYSIS

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Safety Function Capability	General Remarks
Bypass Flow Control Valves (typical)	To close fully	1-6	Fails to close	Position indication ESF status monitoring	(See above)	
Electrical Auxiliary Building						
EAB outside air heating coil	None	1-6	Fails to deenergize on receipt of SI signal	Temperature Hi/Lo alarm ESF status monitoring	None - Temperature control will act as backup	
Supply air intake damper (typical) DA209, DA210, DA211	To close	1-6	Fails to remain partly closed (i.e., opens fully)	Position indication ESF status monitoring	None - Each train is 50% thus the loss of one train will leave a 100% capacity	
Supply fan (typical)	Operate and supply air	1-6	One fan fails to provide adequate flow	Status indication ESF status monitoring	None - A loss of one 50% train will result in 100% capacity still being available	
Supply air cooling coil (typical)	Operate and provide cooling	1-6	One coil fails to provide adequate cooling	Discharge air temperature Hi alarm	(See above)	

* Plant Modes

1. Power Operation
2. Startup
3. Hot Standby
4. Hot Shutdown
5. Cold Shutdown
6. Refueling

TABLE 9.4-5.1 (Continued)

CONTROL ROOM & ELECTRICAL AUXILIARY BUILDING HVAC
FAILURE MODES AND EFFECTS ANALYSIS

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Safety Function Capability	General Remarks
Supply AHU heating elements (typical)	None	1-6	One fails to deenergize upon receipt of SI signal	ESF status monitoring	(See above)	
Heating element exhaust dampers (typical) DA293, DA295, DA297	To close	1-6	One fails open	Position indication ESF status monitoring	(See above)	
Cooling coil exhaust dampers (typical) DA292, DA294, DA296	To open	1-6	One fails closed	Position indication Discharge temperature Hi alarm ESF status monitoring	None - A loss of one 50% train will result in 100% capacity still being available	
Return air fans (typical)	To operate and provide flow	1-6	One fails to operate	Position indication ESF status monitoring	(See above)	
Recirculation dampers: DA212, DA213, DA214	To open	1-6	One fails closed	Position indication ESF status monitoring	(See above)	

* Plant Modes

1. Power Operation
2. Startup
3. Hot Standby
4. Hot Shutdown
5. Cold Shutdown
6. Refueling

TABLE 9.4-5.1 (Continued)

CONTROL ROOM & ELECTRICAL AUXILIARY BUILDING HVAC
FAILURE MODES AND EFFECTS ANALYSIS

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Safety Function Capability	General Remarks
Battery room exhaust fan (typical)	To operate and provide flow	1-6	One fails to operate	Status indication ESF status monitoring	(See above)	
Duct reheat coil for offices (typical)	None	1-6	One fails to deenergize upon receipt of the SI signal	ESF status monitoring	None - Temperature control will act as a backup	
1E Battery room duct reheat coil (typical)	To operate and maintain the battery room temperatures	1-6	One element fails to provide adequate heating or provides excessive heating	None	None - Redundant battery rooms will provide an adequate source of power	
Electrical penetration room AHU (typical)	Operate and provide cooling	1-6	One AHU fails to provide adequate cooling	ESF status monitoring High temperature alarm	None - The two remaining penetration rooms will be provided with cooling	
Backdraft dampers (typical)	Open and allow flow	1-6	One fails to open	None	None - The other redundant trains will supply adequate capacity	
Instrument Air	None	1-6	Air is lost	Header pressure indication and alarms	None - All air-operated components go to their safe position	

* Plant Modes

1.	Power Operation	4.	Hot Shutdown
2.	Startup	5.	Cold Shutdown
3.	Hot Standby	6.	Refueling

TABLE 9.4-5.1 (Continued)

CONTROL ROOM & ELECTRICAL AUXILIARY BUILDING HVAC
FAILURE MODES AND EFFECTS ANALYSIS

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Safety Function Capability	General Remarks
Class 1E AC Power (typical 3 trains)	Provide power to the respective train components	1-6	Loss of power on bus	Bus under voltage alarms ESF status monitoring	None - The other two trains will provide adequate power for safety functions	
ESF Actuation System (typical 3 trains)	Provide actuation signals as required	1-6	One train fails to operate	Individual bistables used to generate the actuation signals are alarmed and annunciated on the main control board	None - The system safety function is assured by actuation of the other trains	
Channel AC Power (I, III, IV)	Provide 1E Power	1-6	Lose a channel	Computer indication of a failure	None - Other channels provide an adequate power supply	

* Plant Modes

1. Power Operation
2. Startup
3. Hot Standby
4. Hot Shutdown
5. Cold Shutdown
6. Refueling

TABLE 9.4-5.2

FUEL HANDLING BUILDING HVAC
FAILURE MODES AND EFFECTS ANALYSIS

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Safety Function Capability	General Remarks
Radiation monitors (typical) (normally energized)	Operate and monitor the radiation level in the exhaust air	1-6	One monitor fails	CRT display: alarm	None - A redundant monitor is provided	
Filter train inlet dampers (typical) (normally closed)	Open and allow flow thru the filter trains	1-6	One damper fails to open	Position indication lights ESF status monitoring	None - A redundant inlet damper is available to allow flow to a 100% filter train	
Normal exhaust isolation damper (typical) (normally open)	Close to direct flow thru the filter units	1-6	One damper fails to close	Position indication lights ESF status monitoring	None - A redundant damper in series will isolate the flow	
Filtration train exit damper (typical) (normally closed)	Opens to allow flow through the filter units and control flow from the FHB	1-6	One damper fails to open	Position indication lights ESF status monitoring	None - The redundant damper for the other 100% filter train is available	

* Plant Modes

1. Power Operation
2. Startup
3. Hot Standby
4. Hot Shutdown
5. Cold Shutdown
6. Refueling

TABLE 9.4-5.2 (Continued)

FUEL HANDLING BUILDING HVAC
FAILURE MODES AND EFFECTS ANALYSIS

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Safety Function Capability	General Remarks
Exhaust booster fan (typical) (normally deenergized)	Operate and exhaust air through filter units	1-6	One fan fails to operate	Status indicating lights ESF status monitoring Low Δ P alarm	None - Since each fan is 50% capacity there will be 100% capacity available	
Fan back draft dampers (typical)	Open and allow flow	1-6	One damper fails to open	None	(See above)	
Main exhaust fan (typical) (normally energized)	Operate and exhaust air from the FHB	1-6	One fan fails to operate	Status indicating lights ESF status monitoring Low Δ P alarm	(See above)	
Makeup air dampers (typical) (normally closed)	Open to allow flow	1-6	One fails to open	Position indication lights ESF status monitoring	None - The second damper in parallel will provide adequate flow	
Supply fans (typical) (normally energized)	None (provides flow to the FHB during normal operation)	1-6	One fan fails to stop running upon the receipt of the ESF signal	Status indicating lights	None - The operation of one fan will not result in loss of 1/8" negative pressure in the FHB	

* Plant Modes

1. Power Operation
2. Startup
3. Hot Standby
4. Hot Shutdown
5. Cold Shutdown
6. Refueling

TABLE 9.4-5.2 (Continued)

FUEL HANDLING BUILDING HVAC
FAILURE MODES AND EFFECTS ANALYSIS

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Safety Function Capability	General Remarks
Spent fuel pool pump room coolers (typical) (normally energized)	Operate and provide cooling	1-6	One cooler fails to provide adequate cooling	Status indicating lights High temperature alarm	None - The reduction of the cooling supplied by the failed pump (as a result of the failed cooler) is acceptable	
Isolation valve cubicle coolers (typical) (normally energized)	Operate and provide cooling	1-4	One cooler fails to provide adequate cooling	Status indicating lights ESF status monitoring	None - All three 50% ECCS trains have separate coolers; thus, failure of one 50% train will leave a 100% capacity of the ECCS systems	
ECCS pumps supplementary coolers (typical) (normally energized)	Operate and provide cooling	1-4	One cooler fails to provide adequate cooling	Status indicating lights ESF status monitoring	None - All three 50% ECCS trains have separate coolers; thus, failure of one 50% train will leave a 100% capacity of the ECCS systems	
Filter unit outlet dampers (normally closed)	Manually positioned by remote signal	1-6	One damper fails to respond	Status indicating lights ESF status monitoring	None - The other 100% filter train will provide adequate filtration. No credit is taken in the accident analysis for filtration.	
Filter unit heaters (normally energized)	Operate and heat the air prior to entry to the charcoal filters	1-6	One coil fails	ESF status monitoring	None - The other 100% filter train will provide adequate filtration. No credit is taken in the accident analysis for filtration.	

* Plant Modes

1. Power Operation	4. Hot Shutdown
2. Startup	5. Cold Shutdown
3. Hot Standby	6. Refueling

TABLE 9.4-5.2 (Continued)

FUEL HANDLING BUILDING HVAC
FAILURE MODES AND EFFECTS ANALYSIS

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Safety Function Capability	General Remarks
Filter Unit Filters	Remove radioactive particulates and iodine from FHB exhaust air	1-6	One filter clogs or charcoal filter degrades	High ΔP alarm Periodic testing	None - The other 100% filter train will provide adequate filtration capability. No credit is taken in the accident analysis for filtration.	
Class 1E AC Power (typical 3 trains)	Provide power to the respective train components	1-6	Loss of power on bus	Bus undervoltage alarms ESF status monitoring	None - The other two trains will provide adequate power for safety functions. Electro-hydraulic dampers will lose power and fail closed. No credit is taken in the accident analysis for filtration.	
ESF Actuation System (typical 3 trains)	Provide actuation signals as required	1-6	One train fails to operate	Individual bistables used to generate the actuation signals are alarmed and annunciated on the main control board	None - The system safety function is assured by actuation of the other trains . No credit is taken in the accident analysis for filtration.	
Instrument Air	None	1-6	Air is lost	Header pressure indication and alarms	None - All air-operated components go to their safe position	
Channels I and IV AC power and Channel I and III DC Power	Provide 1E power	1-6	Loss of power	ESF status monitoring	None - Other channels provide an adequate power supply	

* Plant Modes

1. Power Operation	4. Hot Shutdown
2. Startup	5. Cold Shutdown
3. Hot Standby	6. Refueling

TABLE 9.4-5.3

MECHANICAL AUXILIARY BUILDING HVAC

FAILURE MODES AND EFFECTS ANALYSIS

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Safety Function Capability	General Remarks
Safety air- handling units (typical for train related coolers)	Operate and supply cooling	1-6	One unit fails to provide cooling	ESF status monitoring Hi temperature alarm	None - Since these units are train-related their failure will not impact the ability of the other trains to provide their safety functions	
Safety air- handling units (typical for redundant AHUs in one room)	Operate and supply cooling	1-6	One unit fails to provide cooling	ESF status monitoring Hi temperature alarm	None - The redundant AHU will supply adequate cooling	
Class 1E AC Power (typical)	Provide power to the respective trains	1-6	One train fails	Bus undervoltage ESF status monitoring	None - For the train- related coolers the failure will not impact the ability of other trains from providing the safety function. For the redundant AHUs in one room, the redundant AHU on a different power train will be adequate	

* Plant Modes

1. Power Operation
2. Startup
3. Hot Standby
4. Hot Shutdown
5. Cold Shutdown
6. Refueling

TABLE 9.4-5.5

REACTOR CONTAINMENT BUILDING HVAC
FAILURE MODES AND EFFECTS ANALYSIS

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Safety Function Capability	General Remarks
RCFC						Refer to Section 6.2.2
Containment Cubicle Exhaust Fans (typical) (normally energized)	Operate and exhaust air from the cubicles	1-6	One fan fails	Low ΔP Fan status ESF monitoring	None - Another 100% capacity fan is available	
Backdraft dampers (typical)	Open and allow flow	1-6	One fails to open	None	(See above)	
Supplementary Containment purge valves (typical) (normally open)	To isolate the Containment	1-6	One fails to close	Position indicator ESF status monitoring	None - The redundant valve in series will close	
Normal Containment purge valves (typical) (normally closed)	To isolate the Containment	1-6	One fails to close	(See above)	(See above)	
Radiation monitors (typical) (normally energized)	Operate and provide an isolation signal to the purge lines	1-6	One monitor fails	CRT alarm and display	None - A redundant monitor is provided	

* Plant Modes

1. Power Operation
2. Startup
3. Hot Standby
4. Hot Shutdown
5. Cold Shutdown
6. Refueling

TABLE 9.4-5.5 (Continued)

REACTOR CONTAINMENT BUILDING HVAC
FAILURE MODES AND EFFECTS ANALYSIS

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Safety Function Capability	General Remarks
Class 1E AC Power (typical)	Provide power to the respective trains	1-6	One train fails	Bus undervoltage alarms ESF status monitoring	None - The other two trains will provide adequate power for safety functions	
ESF Actuation system (typical)	Provide actuation signals as required	1-6	One train fails to operate	Individual bistables used to generate the actuation signals are alarmed and annunciated on the main control board	None - The system safety function is assured by actuation of the other trains	
Channel AC Power (typical I and IV)	Provide 1E power	1-6	Lose a channel	Computer indication of a failure	None - Other channels provide an adequate power supply	

* Plant Modes

1. Power Operation
2. Startup
3. Hot Standby
4. Hot Shutdown
5. Cold Shutdown
6. Refueling

TABLE 9.4-5.6

DIESEL-GENERATOR BUILDING HVAC
FAILURE MODES AND EFFECTS ANALYSIS

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Safety Function Capability	General Remarks
Emergency Supply Fans (typical)	Operate and maintain its associated engine room within the design temperatures	1-6	Fan fails to deliver adequate flow	Fan status lights Room high temperature alarm Low ΔP alarm	None - The two remaining diesels can perform all the safety functions	
Recirculation dampers (typical) (normally open)	Fail close to prevent short circuiting of the emergency cooling	1-6	Damper does not close	Damper status light Room high temperature alarm	(See above)	
Backdraft Damper (typical) (normally closed)	Open to allow flow	1-6	Damper fails to open	Room high temperature alarm	(See above)	
Instrument Air	None	1-6	Fails	Header pressure indication and alarm in conjunction with the damper position indication	None - Dampers fail in the emergency position	

* Plant Modes

1. Power Operation
2. Startup
3. Hot Standby
4. Hot Shutdown
5. Cold Shutdown
6. Refueling

TABLE 9.4-5.6 (Continued)

DIESEL-GENERATOR BUILDING HVAC
FAILURE MODES AND EFFECTS ANALYSIS

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Safety Function Capability	General Remarks
Class 1E AC (typical all trains)	Provide power	1-6	Loss of train power	ESF status monitoring of the diesel Bus undervoltage alarms	None – The other diesel trains are available to provide the safety power	
Unit Heaters	None	1-6	Unit heaters operating inadvertently when heating is not required	High-High temperature alarm	None – The other diesel trains are available	

* Plant Modes
1. Power Operation
2. Startup
3. Hot Standby
4. Hot Shutdown
5. Cold Shutdown
6. Refueling

TABLE 9.4-5.7

MISCELLANEOUS BUILDING HVAC
FAILURE MODES AND EFFECTS ANALYSIS

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Safety Function Capability	General Remarks
Essential Cooling Water Intake Structure						
Ventilation Fans (typical) (normally energized)	Operate and exhaust air from the pump cubicle	1-6	One fan fails	Status indication ESF status indication	None - Since the ECW is composed of three 50% trains	
Intake and Exhaust Dampers (typical) (normally open)	Open and allow flow	1-6	One fails closed	Position indication ESF status monitoring	(See above)	
Instrument Air	None	1-6	Air is lost	Header pressure indication and alarms	None - All air-operated components go to their safe position	
Class 1E AC Power (typical 3 trains)	Provide power to the respective trains	1-6	One train fails	Bus undervoltage alarms ESF status monitoring	None - The other two trains will provide adequate power for safety functions	
Unit Heaters	None	1-6	Unit heaters operating	High-High temperature alarm	None - The other two trains are available	

* Plant Modes

1. Power Operation
2. Startup
3. Hot Standby
4. Hot Shutdown
5. Cold Shutdown
6. Refueling

TABLE 9.4-5.7 (Continued)

MISCELLANEOUS BUILDING HVAC
FAILURE MODES AND EFFECTS ANALYSIS

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Safety Function Capability	General Remarks
ESF Actuation System (typical 3 trains)	Provide actuation signals as required	1-6	One train fails to operate	Individual bistables used to generate the actuation signals are alarmed and annunciated on the main control board	None – The system safety function is assured by actuation of the other trains.	
Channel AC Power (typical I, III, IV)	Provide 1E power	1-6	Lose a channel	Computer indication of a failure	None - Other channels provide an adequate power supply	

* Plant Modes
1. Power Operation
2. Startup
3. Hot Standby
4. Hot Shutdown
5. Cold Shutdown
6. Refueling

TABLE 9.4-5.8

MAIN STEAM ISOLATION VALVE CUBICLE HVAC
FAILURE MODES AND EFFECTS ANALYSIS

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Safety Function Capability	General Remarks
Supply Fan (typical)	Operate and supply cooling air	1-6	Fan fails to provide adequate flow	Status lights ESF status monitoring	None - At least two other trains will be available to provide safe shutdown	
Class 1E AC Power (typical 3 trains)	Provide power to the respective trains	1-6	One train fails	Bus undervoltage alarms ESF status monitoring	None - At least two trains will be available to provide adequate power for safety functions	

* Plant Modes
1. Power Operation
2. Startup
3. Hot Standby
4. Hot Shutdown
5. Cold Shutdown
6. Refueling

9.5 OTHER AUXILIARY SYSTEMS

9.5.1 Fire Protection System

9.5.1.1 Design Bases. The overall Fire Protection Program for the South Texas Project Electric Generating Station (STPEGS) is based upon an adequately balanced, defense-in-depth, fire protection approach which incorporates measures for the prevention of fires, but also includes means for the early detection and suppression of any fires which may occur. The program also provides assurance that any such fires will not impair the ability to perform a safe shutdown and will not result in radioactive releases to the environment greater than those permitted by 10CFR100.

The Fire Protection System is designed utilizing the Nuclear Regulatory Commission (NRC) guidelines of Appendix A to Branch Technical Position (BTP) Auxiliary and Power Conversion Systems Branch (APCSB) 9.5-1, 10CFR50 Appendix R, "Fire Protection for Nuclear Power Facilities Operating Prior to January 1, 1979", the recommendations of the American Nuclear Insurers (ANI, formerly Nuclear Energy Liability Property Insurance Association, NELPIA), the applicable standards of the National Fire Protection Association (NFPA), and the requirements of General Design Criterion (GDC) 3 (See Section 3.1). Section 9.5.1 discusses the system description and design basis for the Fire Protection System whereas a more detailed discussion of Appendix A of BTP APCSB 9.5-1 and 10CFR50, Appendix R is contained in the Fire Hazard Analysis Report (FHAR) which was submitted to the NRC under separate cover.

In conducting the fire hazard analysis, potential fire hazards throughout the plant were identified, and combustibles in safety-related areas were tabulated on a fire-zone-by-fire-zone basis. Systems and components required for safe shutdown were identified and located. Fire areas were defined, with some fire areas being subdivided into zones. The designated fire areas are separated by 3-hour fire barriers shown on FHAR Figures 3-1 through 3-39, and FHAR Figures 3-47 through 3-50 and are described in detail in the FHAR. Analyses were performed for each fire area to evaluate the effects of postulated fires. More detail concerning the methodology and results of the fire hazard analysis is provided in the FHAR. Designated fire areas for the Turbine Generator Building (TGB) are shown on UFSAR Figures 9.5.1-40 through 9.5.1-46, and Figure 9.5.1-50 shows the legends and symbols.

To summarize the conclusions of the analysis, a fire occurring within or adjacent to any of the safety-related structures would not prevent the safe shutdown of the reactor and would not result in an uncontrolled release of radioactivity which would constitute a significant fraction of the 10CFR100 limits. The Fire Protection System failure modes and effects analysis (FMEA) is provided in Table 9.5-1.

Redundant safety-related systems and components are generally compartmentalized within heavy concrete walls so that they are unlikely to be damaged from a single fire. Separate fire areas are developed for separate divisions of safe shutdown systems except as modified by the guidance of Appendix R:III.G.2.d, e, and f which applies to fire protection inside non-inerted containments. This provides compliance with Appendix A: A.2 of BTP APCSB 9.5-1 and 10CFR50 Appendix R:III.G which ensures separation of the capability to achieve and maintain safe shutdown conditions.

In all cases, adequate fire detection and protection of the systems and components are provided to allow the fire brigade to manually extinguish the fire and bring the plant to cold shutdown. The protection provided for each of these areas is described in the FHAR.

In the cases where physical separation as a means of fire protection is not practicable, adequate fire detection and protection are installed. The protection provided is composed of fire suppression systems, the use of fire-retardant coatings, thermal barriers or fire stops, or a combination of these, as indicated in the FHAR.

Fire stops are installed in cable trays at rated fire barrier penetrations or specific deviations are identified and justified in the FHAR.

The isolation and separation criteria utilized in the multi-train design of safe shutdown systems, together with the use of manual fire suppression systems and rated fire barriers, limit the effects of a fire such that at least one safe shutdown path will remain available.

Safety-related structures are primarily of reinforced concrete construction on a structural steel framing and provide ample inherent fire resistance for walls, floors, and ceilings which separate redundant systems. Exposed structural steel is protected with spray-applied fireproofing material having a fire rating of at least 3 hours except where it was deemed unnecessary due to the low fire loading.

Within the safety-related structures, interior walls, partitions, structural components, and materials for insulation, radiation shielding and sound-proofing are noncombustible or have acceptably low ratings for fuel contribution, flame spread, and smoke development. Interior finishes at STPEGS are non-combustible as defined in Branch Technical Position CMEB 9.5-1:

a) the finishes will not ignite, burn, support combustion, or release flammable vapors when subjected to heat; or

b) the finishes have a structural base of non-combustible material, are not over 1/8-inch in thickness, and have a flame spread rating that is not higher than 50 when measured using ASTM E-84 Test, "Surface Burning Characteristics of Building Materials"; or

c) the finishes (as oil-based or water-based paints) are applied to the following non-combustible materials in thin films:

    1) plaster, acoustic plaster, gypsum plaster-board (gypsum wallboard),

    2) brick, stone, concrete blocks, and concrete slabs,

    3) steel and aluminum panels, and

    4) structural steel, support steel, and the containment liner.

The use of suspended ceilings within safety-related structures is minimized. Where these ceilings are necessary, such as in the control room, personnel facilities, health physics area and offices, the ceilings and their supports are of noncombustible construction. The spaces above the suspended ceilings may contain lighting and communication circuits in steel conduit or fire detection circuits in aluminum sheathing (ALS). A wet pipe sprinkler system is provided for the one case where open cable trays are routed above a suspended ceiling and are not readily accessible. Walkways are provided for access above the portion of the control room with a suspended ceiling.

Adequate floor drains are installed throughout safety-related buildings and are sized to remove the expected water flows of the fixed fire protection systems and hose streams from the standpipe systems. The switchgear room, El. 35 ft (Room 212), which has a manual drypipe preaction sprinkler system, is provided with floor drains to prevent runoff from entering the control room (CR). The other two switchgear rooms, at El. 10 ft (Room 010) and El. 60 ft (Room 318), are not provided with floor drains because water runoff is removed by drains in adjacent corridors and rooms. Certain areas such as the CR, which are not provided with fixed water spray or sprinkler systems, are not provided with floor drains. Any water from hose streams used in these areas is removed by the adjacent corridor drains, and precautions have been taken in these areas to prevent runoff water from damaging safety-related equipment. Floor drains which may collect water from a radioactive area are routed to the Liquid Waste Processing System (LWPS). Drains in areas containing combustible liquids are designed to prevent the possibility of fire spreading from one area to another through the drainage system.

As in the majority of fires, the principal toxic gas produced by a fire occurring in areas where manual fire suppression will be used would be carbon monoxide. Other toxic gases may be evolved in small quantities, depending upon the exact composition of any combustibles located in the vicinity of a fire. The removal of smoke and toxic gases required to enable fire-fighting personnel to enter an area is discussed in the FHAR, Section 2.4.3.4.

Equipment in the fire protection systems conforms to the standards of the NFPA listed on Table 9.5-2. All known deviations to the NFPA codes have been identified. Exceptions are required for deviations/conditions such as seismic requirements, etc.

9.5.1.2 System Description. Standpipe and hose systems, together with portable extinguishers, are provided in all buildings throughout the plant, except the Demineralizer Building and Circulating Water Intake Structure (CWIS), which are provided with outside fire hydrants, and the Fire Pump House, which is provided with an automatic wet pipe sprinkler and an outside fire hydrant, and the Essential Cooling Water Intake Structure (ECWIS) which is provided with portable extinguishers and outside yard hydrants. In addition, fixed fire suppression systems are installed as required.

The type of fire protection provided for each plant area is provided in Table 9.5-3 and is discussed in greater detail by fire area and zone in Section 3.0 of the FHAR.

Fire Protection System Piping and Instrument Diagrams (P&IDs) are provided as Figures 9.5.1-51 through 9.5.1-57.

9.5.1.2.1 Fire Protection Water Supply System: Plant fire protection systems which utilize water are supplied by an underground piping ring main system. This underground ring main is installed in accordance with the requirements of NFPA 24. The system piping is of cement-lined, ductile iron. The entire underground piping system is cathodically protected.

The STPEGS plant layout comprises two units, approximately 600 ft apart. The underground ring main encompasses both units, and a cross-connection routed between the units connects the north and south sides of the ring to form a figure-eight configuration. The piping used in the primary ring main is of 14-in. nominal size, and can supply the largest water demand of any hazard if that part of the main which would have normally provided the shortest path to the hazard area is out of service. The piping is arranged such that no single break will cause the loss of more than one fire pump or shut off all fire protection water to any area of the plant.

Sectional isolation valves of the post indicator type are installed in the ring main to permit the isolation of any part of the main without removing coverage from any area of the plant.

Branches are taken from the ring main to supply the building internal protection systems and the special equipment protection systems, as required. Post indicator valves are installed in all such branches as they leave the main, to permit the isolation of any system.

In addition to supplying the building internal and special equipment protection systems, the ring main also provides water for the Yard Fire Protection System. This system comprises fire hydrants strategically located at approximately 250-ft intervals to provide a good fire-fighting capability. Special attention is given to the placement of hydrants in the vicinity of fire hazards such as the turbine lube oil area, oil-filled transformers, auxiliary boiler, fuel oil storage area, etc. Each Quality Related fire hydrant is provided a hose house which, as a minimum, is equipped with hoses and nozzles as required by NFPA 24. Hydrants are two-way and are fitted with hose valves. Threads on hydrant hose valves and hose equipment are National Hose Thread. This hose thread is also used by fire departments and brigades in the vicinity of the site.

Three Underwriters' Laboratories (UL)-listed fire water pumps, installed in three separate cubicles within a fire pump house, are used to provide the required water pressure and flow in the system. Prior to fire water pump start, required water pressure is maintained by an electric jockey pump.

Each pump is complete with a diesel-engine driver, a fire pump controller, dual starting batteries, and a 550-gallon diesel fuel oil storage tank. The three pumps, complete with the above accessories, are separated by 3-hour-rated fire barriers and the entire building is provided with a wet pipe sprinkler fire protection system. The entire fire pump installation meets or exceeds the requirements of NFPA 20 and required alarms are transmitted to the Unit 1 CR.

Each pump has a rated capacity of 2,500 gal/min at 125 psig and is capable of providing at least 150 percent of the rated capacity at not less than 65 percent of the total rated head. Each one of the three pumps can provide 100 percent of the flow required for any single system protecting a safety-related area including ample flow for additional hose streams. All three pumps discharge into a common header which forms part of the ring main system.

The three pumps take suction through 14-inch-diameter suction pipes from a 16-inch-diameter header which in turn is supplied with water from two 300,000-gallon fire water storage tanks. Two 14-inch-diameter pipe connections are provided between each storage tank and the 16-inch-diameter header (total four 14-inch-diameter pipes). Isolating valves are provided at the suction nozzles of the tanks and in each of the l4-inch-diameter pipes as they join the header. Similar valves are provided in the 16-in. header and in each of the three 14-inch-diameter pump suction lines as they leave the header. Thus, any pump or combination of pumps can take suction from either or both fire water storage tanks. In addition, a check valve is provided adjacent to the isolating valve on each of the four tank suction lines at the header so that a rupture or leak in either tank does not permit the other tank to be drained through the interconnecting piping. Both tanks are used only for fire water storage, and no outlets are provided for connection to any other system.

The water supply to refill the fire water storage tanks is normally provided from the Fresh Water System, which takes suction from a settling basin and can refill one tank in 8 hours or less. In the event of a failure in this system, the tank is refilled directly from the site well water system.

9.5.1.2.2 Cabling Areas: Most major cabling areas outside Containment are enclosed by 3-hour fire barriers. Automatic wet pipe sprinkler protection, at the ceiling level, is provided throughout the cable spreading rooms and power cable vault. For concentrated cable in trays outside of the cable spreading rooms and power cable vault where the cable tray sections are not readily accessible to an effective hose stream, automatic wet pipe sprinkler systems are provided at the ceiling level. The sprinkler systems are hydraulically designed to provide an average density of 0.3 gal/min-ft^2 over any 3,000 ft^2 of floor area. Specific areas covered are described in detail in Section 3.0 of the FHAR.

In addition to automatic fire suppression, standpipes with hoses and portable extinguishers are provided throughout the building. Cables used in these areas are designed to be wetted without electrical faulting.

Each cabling area contains only one train of redundant safety-related cables except the train B cable spreading/power cable area which contains several train C cable trays. The train C trays pass vertically through the train B area and terminate in the main CR. Alternate shutdown capability is provided for these circuits as described in the FHAR.

Cabling in these areas meets the Institute of Electrical and Electronics Engineers (IEEE) 383 flame test with specific exceptions as noted in the FHAR.

Within each separate cable division, different classes of cables, such as medium-voltage cables, low-voltage cables, and instrument cables, are installed in cable trays or raceways specifically dedicated to each class. Where cable trays are arranged in tiers, the cables are installed in the tiers in order of fault energy, whenever possible, with the highest fault energy cables in the upper trays and instrumentation cables in the lower trays.

Spatial separation is provided between cables of redundant safety-related divisions, and also between cables of safety-related and nonsafety-related divisions, in accordance with the requirements of IEEE Standard 384 and Regulatory Guide (RG) 1.75.

9.5.1.2.3 Switchgear Rooms: The train A, B, and C switchgear rooms are separated from each other by 3-hour fire barriers. Each switchgear room is provided with fire detection and alarms (Section 9.5.1.2.19) and with a special hazards preaction sprinkler system consisting of manually actuated, dry-pipe, air-supervised sprinkler system with closed head sprinklers. Portable carbon-dioxide-type extinguishers are provided adjacent to the switchgear rooms, and manual hose stations on the building standpipe system are available in the vicinity of each switchgear room. Only variable pattern nozzles having no straight stream capability and specifically approved for use on electrical fires are installed on hose stations in the vicinity of switchgear rooms.

Cables passing through the Engineered Safety Features (ESF) switchgear rooms, and not directly associated with those rooms, are kept to a minimum.

9.5.1.2.4 Battery Rooms: The train A, B, and C safety-related battery rooms are separated from each other and from other trains of safe shutdown equipment by 3-hour fire barriers. The battery room hydrogen concentrations are maintained well below 2 percent by redundant safety-related ventilation systems. Low ventilation flow is alarmed in the CR. Portable fire extinguishers are provided adjacent to the battery rooms, and manual hose stations on the building standpipe system are available in the vicinity of each room. Each battery room is provided with a fire detection system (Section 9.5.1.2.19).

9.5.1.2.5 Control Room: comprehensive system of smoke detectors is installed in the CR consoles and cabinets, in the general room area, and above the suspended ceiling (Section 9.5.1.2.19).

Portable carbon dioxide and pressurized water extinguishers are installed in the CR to provide immediate fire-fighting capability. Extra extinguishers are located in the corridors adjacent to the CR.

In addition, hose stations on the Electrical Auxiliary Building (EAB) standpipe system are located in corridors at opposite ends of the CR, adjacent to the CR doors. Thus, at least one, and normally two, manual hose streams are available to extinguish any fire which is not brought under control quickly by the portable extinguishers. Only variable pattern nozzles having no straight stream capability and specifically approved for use on electrical fires are installed on hose stations in the vicinity of the CR.

The CR area floor, ceiling, supporting structures, and walls, including penetrations and doors, are designed to provide a fire rating of 3 hours unless otherwise noted in the FHAR.

The control room ventilation intake is provided with smoke detectors to automatically close dampers to isolate outside air intake and put the CR envelope heating, ventilating, and air-conditioning (HVAC) system into a 100 percent recirculation mode. Additionally, the HVAC System may be manually switched from recirculation mode to makeup and exhaust mode in order to purge smoke from the CR (Section 9.4).

A manual-electrically operated fixed water spray deluge system is provided for each HVAC carbon filter for the control room clean-up and makeup HVAC system (Section 9.5.1.2.18).

9.5.1.2.6 Relay Cabinet Area of Control Room, Plant Computer Room, and Technical Service Center Computer Room: The relay cabinet area room of each unit is provided with a Halon l30l total flooding fire protection system. Although the plant and Technical Service Center (TSC) computers are not safety-related, the computer rooms and Battery Room 215A of each unit are also provided with a Halon l30l total flooding system.

The Halon systems are of the high-pressure (600 psig), engineered type, specifically designed to produce a uniform concentration of 7 to 7.5 percent by volume of Halon in the rooms they protect. The Halon supply for each system is provided by multiple cylinders of Halon manifolded together to provide the total quantity required for that system.

The Halon discharge from each of the systems is controlled by an individual, electrically operated valve, automatically actuated via a control panel by the fire detection system for that room (Section 9.5.1.2.19). Switches are installed outside the entrances to the rooms to permit manual-electrical operation of a Halon system. In addition, in case of failure of the electrical operator or total failure of both the primary and backup power supplies, each valve has provisions at the Halon cylinders for complete manual operation.
The control panel and the Halon storage cylinders for the relay cabinet area of the control and computer room are located in the Halon Fire Extinguishing System Room at El. 10 ft of the EAB. The TSC computer room Halon storage cylinders and control panel are located near the area protected.

9.5.1.2.7 Diesel Generator Building: Three standby diesel generators (SBDGs) are installed in the Diesel Generator Building (DGB) of each unit. Each diesel generator (DG) is located in an individual room on the ground floor of the building and is provided with a diesel fuel oil storage tank, located in an individual room directly above the DG which it supplies. Each fuel oil tank room is enclosed by a 3-hour fire barrier with a liquid-tight, 24-inch-thick, reinforced concrete floor and a watertight nonlabeled door constructed in accordance with UL requirements.

Each DG train and associated fuel tank is separated laterally from the next train by a 24-inch-thick reinforced concrete 3-hour fire-rated wall, extending the entire width and height of the building. No openings or penetrations are made in these walls.

Fire suppression for each of the three standby DG rooms is provided by individual preaction sprinkler systems. These systems are designed in accordance with the requirements of NFPA l3 and utilize standard, fusible-link sprinkler heads at ceiling level. These systems are designed to discharge water at a density of 0.30 gal/min-ft^2 for any 3,000 ft^2 area over the entire area of the room, with all sprinklers open.

The water inlet to each of the preaction systems is controlled by an individual, electrically operated deluge valve, automatically actuated by the fire detection system for that DG room (Section 9.5.1.2.l9). Switches are installed outside the entrances to the DG rooms to permit manual-electrical operation of the deluge valve. In addition, in case of failure of the deluge valve electrical operator or total failure of both the primary and backup power supplies, each deluge valve has provisions at the valve for complete manual operation.

Each of the three DG rooms is provided with backup fire protection by hose reels and portable extinguishers.

The performance of the diesel engine would not be adversely affected by the sprinkler water discharge, and the electric generator is provided with a shield to prevent water damage. Inadvertent operation of the fire protection system in any one of the DG rooms will not affect the operation of the other two DGs.

Fire suppression for each of the three fuel oil storage tank rooms is provided by individual foam-water sprinkler systems. These systems are designed in accordance with the requirements of NFPA l6, and utilize standard foam-water sprinkler nozzles at ceiling level to discharge foam-liquid solution at a density of not less than 0.16 gal/min-ft^2 over the entire area of the room. Foam-liquid solution is produced by the pressure-proportioning method. A 150-gallon-capacity pressure-proportioning tank, complete with proportioning head, is located immediately outside, and on the same floor, as each fuel oil storage tank room.

The water inlet to each of the foam-water sprinkler systems is controlled by an individual, electrically operated deluge valve, automatically actuated by the fire detection system for that fuel oil storage tank room (Section 9.5.1.2.19). Switches are installed outside the entrances to the fuel oil storage rooms to permit manual-electrical operation of the deluge valve. In addition, in case of failure of the deluge valve electrical operator or total failure of both the primary and backup power supplies, each deluge valve has provisions for complete manual operation at the valve.

Each of the three fuel oil storage rooms is provided with backup fire protection by hose reels and portable extinguishers.

Foam water will not adversely impact the fuel oil tank, come in contact with the fuel oil, or affect the gravity feed process to its diesel engine. Accordingly, spurious actuation or inadvertent manual actuation of one or all of the foam-water sprinkler fire protection systems will not affect DG availability or operability.

9.5.1.2.8 Fuel Handling Building: Early detection of any fire is provided by the Fire Detection System (Section 9.5.1.2.19). The primary means of fire suppression is a standpipe and hose system, supplied from the underground ring main and the internal ring main in the Mechanical Auxiliary Building (MAB). The number of hose stations provided is the optimum required, and their locations are determined by the physical arrangement of the building and the accessibility of the hazards. Each standpipe riser is provided with a shutoff valve. Hose lengths are 75 ft where feasible, but hose lengths of 100 ft are utilized as permitted by NFPA l4. The system design is such that all locations in the building are within reach of at least one hose stream. Woven-jacket, lined fire hoses installed on semiautomatic racks in hose cabinets are used where feasible. Braided, noncollapsible hoses installed on hose reels are used whenever the ability to have a hose stream available immediately, without having to unrack a complete length of hose, is advantageous. A manual-electrically operated fixed water spray deluge system is provided for the HVAC carbon filters (Section 9.5.1.2.18).

Backup fire protection is provided by portable fire extinguishers. The type, size, number, and locations of these extinguishers are determined by the nature of the hazards, and in all cases meet or exceed the requirements of NFPA 10.

9.5.1.2.9 Mechanical Auxiliary Building: Early detection of any fire is provided by the Fire Detection System (Section 9.5.1.2.19). The primary means of fire suppression is a wet standpipe and hose system. The system is composed of an internal ring main at the lower level of the building, supplying standpipes and hose stations. Each standpipe riser is provided with a shutoff valve at the ring main, and the ring is provided with sectional isolating valves, so that the integrity of the system is maintained in the event of a pipe rupture. The building ring main is connected to the plant underground ring main system at two widely separated points.

The number of hose stations provided is the optimum required, and their locations are determined by the physical arrangement of the building and the accessibility of the hazards. Hose lengths are 75 ft where feasible, but hose lengths of 100 ft are utilized as permitted by NFPA 14. The system design is such that all locations in the building are within reach of at least one hose stream. Woven-jacket, lined fire hoses installed on semiautomatic racks in hose cabinets are used where feasible. Braided, noncollapsible hoses installed on hose reels are used whenever the ability to have a hose stream available immediately, without having to unrack a complete length of hose, is advantageous.

In addition to the above standpipe and hose system, the personnel facilities and health physics area on El. 41 ft of the MAB are provided with a wet pipe sprinkler system below the suspended ceiling to extinguish fires and to prevent exposure fires from igniting the cable in the trays above. This system is installed in accordance with the requirements of NFPA 13. For cable tray sections that are not readily accessible to an effective hose stream because of the suspended ceiling, an automatic wet pipe sprinkler system hydraulically designed to a density of 0.3 gal/min-ft^2 over the area covered is installed in portions of the area above the suspended ceiling to aid in cooling and controlling the fire until manual suppression can be accomplished.

An automatic wet pipe sprinkler system to aid in cooling and controlling the fire until manual suppression can be accomplished is also provided for the El. 10 ft pipe penetration area, laundry, waste baler, and truck loading areas and for areas where there are cable tray sections that are not readily accessible to an effective hose stream. MAB areas covered by wet pipe sprinkler systems are shown on FHAR Figures 3-14 through 3-20, 3-22, 3-24, 3-26, and 3-29 through 3-31.

A manual-electrically operated fixed water spray deluge system is provided for the HVAC carbon filters for the chemical lab and sample room (Section 9.5.1.2.18).

Backup fire protection is provided by portable fire extinguishers. The type, size, number, and locations of these extinguishers are determined by the nature of the hazards and meet or exceed the requirements of NFPA 10.

9.5.1.2.10 Electrical Auxiliary Building: Early detection of any fire in the EAB is provided by the Fire Detection System (Section 9.5.1.2.19).

In addition to the sprinkler systems (Sections 9.5.1.2.2 and 9.5.1.2.16) and Halon 1301 Systems (Section 9.5.1.2.6) which are provided for the special hazard areas in the EAB, a complete standpipe and hose system is provided. This system is the same as that described for the MAB, with the exception that the standpipes are supplied by a header instead of a ring main. The header runs the length of the building, and each end is connected to the underground ring main.

A manual-electrically operated fixed water spray deluge system is provided for the HVAC carbon filters in the EAB (Section 9.5.1.2.18).

Backup fire protection is provided by portable extinguishers, the same as for the MAB.

9.5.1.2.11 Turbine Generator Building: The TGB is provided with a comprehensive overall Fire Protection System. This protection includes the use of wet pipe sprinkler systems, standpipe and hose systems, water spray fixed systems, and a fire detection, control, and alarm system.

The entire mezzanine level and the ground floor level (except the switchgear room) are completely protected by wet pipe sprinkler systems. These systems are installed in accordance with the requirements of NFPA l3, for extra hazard occupancy.

Due to the size of the TGB and the limitations imposed by NFPA 13 (25,000-ft^2 coverage for any one system), each level of the building is protected by three separate systems. Each system is hydraulically designed to meet the ANI water density requirements of 0.30 gal/min-ft^2 for any 3,000-ft^2 area and 0.20 gal/min-ft^2 for any 10,000-ft^2 area.

An isolating valve is provided in the water supply lines to each sprinkler system so that the isolation of any one system does not impair the operability/functional capability of any other system. An alarm check valve is also provided in the supply line to each system, immediately downstream from the system isolating valve. The alarm check valve detects any water flow in the system and initiates alarms local to the system and in the main CR (Section 9.5.1.2.19).

The general area closed-head sprinkler systems are supplemented by other systems as follows:

1. Water spray fixed systems protecting the hydrogen seal oil unit, the three Steam Generator (SG) Feed Pump Lube Oil Systems, and the cable tray vault.

2. Manual preaction sprinkler systems protecting the turbine generator (TG) bearings.

The hydrogen seal oil unit is located on the ground floor level of the building and comprises receivers, heat exchangers, and miscellaneous pumps, all mounted on a common baseplate approximately 11 ft by 10 ft. The water spray system utilizes solid cone directional spray nozzles to provide essentially complete, direct impingement onto all exposed surfaces of the unit. The spray system is designed in accordance with the requirements of NFPA 15, and the design density is 0.30 gal/min-ft^2. Curbs and drains are provided around the unit to contain and remove oil and fire protection water.

The water discharge from this system is controlled by an electrically operated deluge valve, automatically actuated by the fire detection system for this equipment (Section 9.5.1.2.19).

The cable tray vault is located below the switchgear room and is approximately 120 ft by 24 ft by 15 ft deep and contains only electrical cables installed in cable trays.

The three SG feed pumps are located on the operating deck and are steam-turbine-driven. Each pump and turbine is mounted on a common baseplate. The turbine lube oil equipment (reservoir, coolers, and associated piping) of each pump is protected by an individual spray system. The overall dimensions of the protected equipment are approximately 6 ft by 12 ft by 6 ft high. The three fire protection and detection systems provided are designed and operated on the same basis as that previously described for the hydrogen seal oil unit. Curbs and drains are provided for each pump to contain and remove oil and fire protection water.

The TG bearings are protected by preaction sprinkler systems utilizing standard fusible link sprinkler heads. The water inlets to these systems are controlled by electrically actuated deluge valves, opened by manual-electrical means, in response to an alarm from one of the fire detectors within a bearing shroud (Section 9.5.1.2.19).

In addition to the sprinkler systems and the special hazard systems, a complete standpipe and hose system is provided for the three levels of the building. The number of hose stations provided is the optimum required, and their locations are determined by the physical arrangement of the building and the accessibility of the hazards. Hose lengths are 75 ft where feasible, but hose lengths of 100 ft are utilized as permitted by NFPA 14. The system design is such that all locations in the building are within reach of at least one hose stream. Braided, noncollapsible hoses installed on hose reels are used throughout the TGB.

Backup fire protection is provided by portable fire extinguishers. The type, size, number, and locations of these extinguishers are determined by the nature of the hazards, but in all cases meet or exceed the requirements of NFPA 10.

The water spray fixed systems, standpipe and hose systems, and preaction sprinkler systems installed in the TGB are supplied with water from a 6-inch-diameter pipe header, having a U-shaped configuration, installed beneath the mezzanine level. The ends of the header are connected to the plant underground ring main system at widely separated points. The header is normally supplied with water from both points of the main, but isolating valves of the post indicator type are provided at the connections to the main, such that the header may be supplied from one point only in the event of damage to part of the main.

In addition, isolating valves of the outside screw and yoke type are installed at each end of the header at the inlets to the building, and also at strategic intervals around the header to permit isolation of any damaged section.

All pipe connections from the header to fire protection systems and standpipes are provided with isolating valves as they leave the header, such that the isolation of any one system does not affect the operability/functional capability of any other system.

The automatic wet pipe sprinkler systems in the TGB are supplied with water directly from the underground ring main. In addition, a backup supply is provided from the TGB internal header.

9.5.1.2.12 Turbine Lube Oil Area: The turbine lube oil area comprises a lube oil reservoir, clean and dirty oil storage tanks, and a lube oil conditioner located outdoors and adjacent to the southwest corner of the TGB. The lube oil reservoir is a horizontally positioned cylindrical steel tank, 114 inches in diameter by 432 inches in length, located on a curbed concrete slab at El. 44 ft. The clean and dirty oil tanks are cylindrical steel tanks, of 23,000 gallons each, located at El. 21.5 ft below the reservoir. Two-hour fire-rated walls are provided for the TGB adjacent to the lube oil area for exposure protection.

The lube oil area is protected by two independent water spray fixed systems: one for the reservoir at El. 44 ft and one for the tanks and conditioner below. These systems utilize solid cone directional spray nozzles to provide essentially complete direct impingement onto exposed surfaces of the equipment, including floor areas within the curbs. The spray systems are designed in accordance with the requirements of NFPA l5, and the design densities are 0.25 gal/min-ft^2.

Water is supplied for these systems directly from the underground ring main. The discharge for each system is controlled by an electrically operated deluge valve located within the TGB, actuated by the Fire Detection System for the lube oil area (Section 9.5.1.2.l9). In case of failure of the deluge valve electrical operator, or total failure of both the primary and backup power supplies, each deluge valve has provisions for complete manual operation at the valve.

9.5.1.2.13 Transformers: All oil-filled transformers are installed outdoors and are provided with pits to catch any transformer oil which may be released due to a leak or rupture.

Those transformers that are protected by water spray deluge systems are listed in Table 9.5-3. These systems utilize solid cone directional spray nozzles to provide essentially complete direct impingement onto exposed surfaces of the transformers, including the oil coolers. The spray systems are designed in accordance with the requirements of NFPA 15, and the design densities are 0.25 gal/min-ft^2 of projected area of rectangular prism envelope for the transformer and appurtenances, and not less than 0.15 gal/min-ft^2 on the expected nonabsorbing ground surface area of exposure.
The water discharge from each system is controlled by an electrically operated deluge valve, automatically actuated by the Fire Detection System for that transformer (Section 9.5.1.2.19). In case of failure of the deluge valve electrical operator, or total failure of both primary and backup power supplies, each deluge valve has provisions at the valve for complete manual operation.

9.5.1.2.14 Isolation Valve Cubicle: Primary fire suppression is provided by a standpipe and hose system supplied from the underground ring main. The number of hose stations provided is the optimum required, and their locations are determined by the physical arrangement of the building and the accessibility of the hazards. Each standpipe is provided with a shutoff valve. Hose lengths are 75 ft where feasible, but hose lengths of 100 ft are utilized as permitted by NFPA 14. The system design is such that all hazards in the building are within reach of at least one hose stream.

Backup fire protection is provided by portable extinguishers. The type, size, number, and locations of these extinguishers are determined by the nature of the hazards, and in all cases meet or exceed the requirements of NFPA 10.

Ionization and/or smoke detectors are provided in each zone, except Zone Z404, to ensure early warning and locate fires for manual fire fighting. Fire detection instrumentation is not required for Z404 because there are no combustible materials or safety-related components located in the zone.

9.5.1.2.15 Reactor Containment Building: Thermostatic spot-type detectors with rate compensation are provided for the reactor coolant pumps (RCPs) and thermal line type detectors are provided for the cable trays to provide early detection of a fire. Continuous thermistor type detectors are provided for charcoal filters (Section 9.5.1.2.18). The primary fire suppression is provided by a standpipe and hose system. In addition, a manually-operated special hazard fixed water spray system designed in accordance with the requirements of NFPA is provided above and below train B cable trays. These two systems are hydraulically designed to provide an average density of 0.30 gal/min-ft^2 over 3,000 ft^2 of floor area. The deluge valves for these systems are manually actuated by hand switches located in the CR. The water supply to hoses and fixed spray systems is controlled by one motor-operated Containment isolation valve. The motor-operated valve (MOV) is operated from the CR. In addition to the MOV, a check valve is provided within the RCB for Containment isolation purposes. The valving arrangement inside Containment allows water into the standpipe system while isolating the manually operated fixed spray systems. The number of hose stations provided is the optimum required, and their locations are determined by the physical arrangement of the building and the accessibility of the hazards. Each standpipe riser is provided with a shutoff valve. Hose lengths are 75 ft where feasible, but hose lengths of 100 ft are utilized as permitted by NFPA 14.

The standpipe and hose system design is such that hazards in the building are within reach of at least one hose stream. Woven-jacket, lined fire hoses installed on semiautomatic racks in hose cabinets are used. A remote manually operated, fixed water spray deluge system is provided for the HVAC carbon filters (Section 9.5.1.2.18).

Backup fire protection is provided by portable extinguishers. The type, size, number, and locations of these extinguishers are determined by the nature of the hazards, and in all cases meet or exceed the requirements of NFPA 10. A lube oil collection system is provided to collect any leakage from the RCPs.

9.5.1.2.16 Cable Trays: Cable trays outside Containment are provided with fixed automatic wet pipe sprinkler systems where concentrations of cable trays exist that are not readily accessible by manual hose streams. These systems are hydraulically designed to provide a density of 0.3 gal/min-ft^2 per any 3,000 ft^2 area over the area covered. The systems are described in Sections 9.5.1.2.2, 9.5.1.2.9, and 9.5.1.2.10.

The water supply for these systems is from the internal ring main within the building in which the cable trays are routed.

An isolating valve is provided in the water supply line to each sprinkler system so that isolation of the system does not impair the operability/functional capability of any other system. An alarm check valve is provided immediately downstream of the isolating valve (Section 9.5.1.2.19).

9.5.1.2.17 Miscellaneous Areas:

9.5.1.2.17.1 Maintenance Operations Facility - This complex is located approximately 200 ft from the nearest safety-related building, which is the Unit 1 Mechanical-Electrical Auxiliaries Building (MEAB), and poses no exposure hazard.

9.5.1.2.17.2 Lighting Diesel Generator Building - Fire suppression for the Lighting Diesel Generator Building is provided by a preaction sprinkler system. This system is designed in accordance with the requirements of NFPA 13 and utilizes standard, fusible-link sprinkler heads at ceiling level. This system is designed to discharge water at a density of 0.30 gal/min-ft^2 over the entire area with all sprinklers open.

The water inlet to the preaction sprinkler system is controlled by an electrically operated deluge valve, automatically actuated by the fire detection system for the Lighting Diesel Generator Building (Section 9.5.1.2.19).

9.5.1.2.17.3 Auxiliary Boilers - The auxiliary boiler is located more than 50 ft from the nearest safety-related building, which is the Unit l MEAB, and pose no exposure hazard. This area is protected by strategically located fire hydrants of the Yard Fire Protection System.

9.5.1.2.17.4 Auxiliary Fuel Oil Storage Tank - The auxiliary fuel oil storage tank (AFOST) is a 240,000-gallon, floating-roof tank located within a diked area.

The tank is protected by a foam system in accordance with NFPA 11 and is designed to apply foam onto the peripheral seal of the floating roof at a rate of 0.40 gal/min-ft^2 for a minimum duration of 20 minutes. A circular dam of steel plate secured to the floating roof is used to form an annular ring between the dam and the tank wall to retain the foam deposited onto the seal. Foam-liquid solution is produced by the pressure-proportioning method. A pressure-proportioning tank complete with proportioning head is located outside the dike in a foam equipment house. Water is supplied directly to the house from the underground ring main.

The water inlet to the proportioning equipment is controlled by an electrically operated deluge valve, automatically actuated by the Fire Detection System (Section 9.5.1.2.19). In case of failure of both the primary and backup power supplies, the deluge valve has provisions at the valve for complete manual operation.

Backup protection is provided from a supplementary foam hose stream, as required by NFPA 11. The water supply to the fire hydrant used in conjunction with this hose stream is from a separate branch off the underground ring main.

9.5.1.2.18 HVAC Carbon Filters: A manual-electrically operated fixed-water-spray deluge system is provided for the HVAC carbon filters in the EAB, MAB, Fuel Handling Building (FHB) and Reactor Containment Building (RCB) of each unit. The areas of protection are as follows:

- Control Room Cleanup Unit, EAB El. 10 ft-0 in.
- Control Room Cleanup Unit, EAB El. 35 ft-0 in
- Control Room Cleanup Unit, EAB El. 60 ft-0 in.
- Technical Support Center Filter Unit, EAB El. 86 ft-0 in.
- Control Room Makeup Unit, EAB El. 86 ft-0 in.
- Control Room Makeup Unit, EAB El. 86 ft-0 in.
- Control Room Makeup Unit, EAB El. 86 ft-0 in.
- Sample Room Filter Unit, MAB El. 41 ft-0 in.
- Radiation Chemistry Lab Filter Unit, MAB El. 41 ft-0 in.
- HVAC Exhaust Subsystem Filter Unit, FHB El. 30 ft-0 in.
- HVAC Exhaust Subsystem Filter Unit, FHB El. 30 ft-0 in.
- HVAC Exhaust Subsystem Filter Unit, FHB El. 42 ft-6 in.
- HVAC Exhaust Subsystem Filter Unit, FHB El. 42 ft-6 in.

- HVAC Exhaust Subsystem Filter Unit, FHB El. 53 ft-3 in.
- HVAC Exhaust Subsystem Filter Unit, FHB E1. 53 ft-3 in.
- Containment Carbon Filter Unit, RCB E1. 52 ft-0 in.
- Containment Carbon Filter Unit, RCB E1. 52 ft-0 in.

The deluge system to each of the carbon filters is designed in accordance with the requirements of NFPA 15 with a design density of not less than 0.25 gal/min-ft^2 for horizontal beds and 3.2 gal/min-ft^2 for vertical beds.

Dual setpoint continuous thermistor type detectors are provided to alarm both high and high-high charcoal temperatures. The deluge valves are manually actuated by hand switches located in the CR and locally. To prevent inadvertent water discharge into the carbon filters, these systems utilize normally closed outside screw and yoke (OS&Y) isolation valves just upstream of the deluge valves. These OS&Y valves are manually opened before actuation of the deluge valves.

9.5.1.2.19 Fire Protection Detection, Control, and Alarm System: A comprehensive Fire Detection, Control, and Alarm System is installed throughout the plant. The primary operation of this system is automatically governed by a series of local control panels conveniently located throughout the plant.

The Fire Protection System control panels monitor the general plant area fire detectors and monitor and/or control all of the special hazard fire protection systems to ensure their continuous availability. Alarms are transmitted from the local panels to the fire protection data acquisition system in the main control room.

Each panel is provided with a 24 vdc emergency battery backup power supply located within the panel or in an enclosure located adjacent to the panel. The battery is capable of operating the system under maximum normal load for 24 hours. Under normal operating conditions the panels operate from non-Class 1E AC power sources.

The fire detection, control and alarm system design and installation in buildings containing safe shutdown equipment complies with the requirements of NFPA 72D, except for the following:
1) The connection wiring between each local addressable module associated with either a "spot" thermal detector or manually activated station. This is not considered to be a significant deviation since each local addressable module is located inside a common enclosure with either the "spot" thermal detector or manually activated station, utilizing connections less than 12" in length.

9.5.1.2.19.1 General Plant Areas - General area fire detectors are installed in every fire area, except as noted in the FHAR, to provide early detection of a fire. The RCB is not provided with a general area Fire Detection System (Section 9.5.1.2.15). The fire detectors installed in any particular room or fire area are the optimum type available and are selected on the basis of the fire hazard analysis and the nature and burning characteristics of the materials within the area. All fire detectors installed in the plant are UL listed, and the number required in any area is governed by the above considerations. However, in no case is the spacing of detectors greater than that stipulated by

UL for each particular detector; and in no case are less than two detectors installed in any single, safety-related fire area, so that a failure of one detector does not render that detection system inoperative.

The following primary types of fire detectors are used:

1. Thermostatic, spot-type, heat detector with rate compensation

2. Photoelectric, spot-type smoke detector

3. Ionization, spot-type smoke detector

4. Thermal line type detector

5. Continuous thermistor type detector

6. Optical flame detector

In addition to the automatic fire detectors, manual pull stations are installed throughout the plant to permit personnel to initiate a fire alarm, if required.

The local control panels continuously monitor the room and fire area general fire detection systems and circuits. Upon receipt of an indication of fire from any of these general area detectors, the control panel activates a fire alarm bell at the panel. These panels are normally located in the vicinity of the areas they monitor, and these alarms are audible within these areas. In situations where the panel alarms are not audible in any particular area, an additional bell is installed close to that area. A visible indication is provided on the panel to show which area is initiating the alarm.

In addition to monitoring for fire conditions, the panels monitor other conditions necessary to ensure the availability and proper operation of each detection system. Upon receipt of a detection system off-normal condition, visible and audible indications of the trouble are provided at the panel.

The off-normal conditions include:

- Detection circuit(s) trouble

- Control panel primary power failure

Normally open contacts are provided in the appropriate control panel for TROUBLE and FIRE conditions for each detection circuit. The contacts are designed to close upon receipt of these conditions and are used to initiate alarms in the CR (Section 9.5.1.2.19.12).

9.5.1.2.19.2 Fire Protection Water Supply - Three 2,500 gal/min diesel-engine-driven fire pumps are provided, each with an individual fire pump controller. The primary function of each controller is to maintain the starter batteries of the associated diesel engines in a charged condition and, upon receipt of a low water pressure signal in the underground ring main system, to start the diesel-engine-driven pumps. The starting of the three diesel engines is sequential at 5-second intervals. Failure of the lead pump to start does not prevent subsequent pumps from starting.

In addition to the above functions, each fire pump controller monitors the following conditions to ensure availability and successful operation of its associated fire pump. Upon receipt of a fire pump/engine off-normal condition, visible and audible indications of the trouble are provided at the controller.

The off-normal conditions include:

- High engine cooling water temperature (automatically trips engine if it occurs during a test run)
- Low oil pressure (automatically trips engine if it occurs during a test run)
- Engine failure to start after 90 seconds
- Low fuel oil level in day tank (automatically trips engine if it occurs during a test run)
- Engine overspeed (automatically trips engine)

Dry contacts for the remote alarm of the following conditions are also provided:

- Pump running
- Battery no. l inoperative
- Battery no. 2 inoperative
- Trouble - engine, controller, or low fuel oil level
- AC power failure (engines automatically started upon loss of AC power)

A local control panel is also provided in the fire pump house to monitor the following conditions to ensure availability and proper operation of the fire protection water supply system. Upon receipt of any off-normal condition, visible and audible indications of the trouble are provided at the panel.

The off-normal conditions include:

- Low water level (fire water storage tank no. l)
- Low water level (fire water storage tank no. 2)
- Isolating valve closed
- Low water temperature (fire water storage tank no. l)
- Low water temperature (fire water storage tank no. 2)
- High water level (fire water storage tank no. l)
- High water level (fire water storage tank no. 2)

- Low water pressure in pump discharge header
- Low fuel oil level (each of three diesel engine fuel oil tanks)

A pair of normally open contacts is provided in the appropriate fire pump controller and control panel for each of the above conditions. The contacts are designed to close upon receipt of these conditions and are used to initiate alarms in the CR (Section 9.5.1.2.19.12).

9.5.1.2.l9.3 Automatic Sprinkler System - A list of areas protected by automatic sprinkler systems is provided in Table 9.5-3. The control panels continuously monitor these systems. Upon receipt of an indication of fire from a system alarm check valve resulting from water flow in the system, the panel activates a fire alarm bell local to the protected area. A visible indication is provided on the panel to show which system is indicating a fire alarm.

In addition to monitoring for fire conditions, the panels monitor other conditions necessary to ensure the availability and proper operation of each sprinkler system. Upon receipt of any off-normal condition, visible and audible indications of the trouble are provided at the panel.

The off-normal conditions include:

- System isolating valve closed
- Control panel primary power failure
- Water flow alarm circuit trouble

A pair of normally open contacts is provided in the appropriate control panel for TROUBLE and FIRE conditions for each sprinkler system. The contacts are designed to close upon receipt of these conditions and are used to initiate alarms in the CR (Section 9.5.1.2.19.12).

9.5.1.2.19.4 Preaction Sprinkler Systems (Manual) - The TG bearings are protected by a preaction sprinkler system. The fire detectors used are thermostatic, spot-type heat detectors with rate compensation.

A control panel continuously monitors the Fire Detection System associated with each preaction sprinkler system. Upon receipt of an indication of fire from any detector, the panel activates a fire alarm bell in the protected area. A visible indication is provided on the panel to show which system is indicating a fire alarm.

Manual switches are located in the main CR to manual-electrically open an electrically actuated deluge valve that controls the water supply to each preaction sprinkler system. Water is then admitted to the system and discharges from any sprinkler heads that open. A WATER FLOWING alarm is also provided in the area of the bearings and in the CR. Upon receipt of this alarm, the operator is assured that the deluge valve has operated.

In addition to monitoring fire conditions, the panels monitor other conditions necessary to ensure the availability and proper operation of each detection and preaction sprinkler system. Upon receipt of any off-normal condition, visible and audible indications of the trouble are provided at the panel.

The off-normal conditions include:

- Detection circuit trouble
- Deluge valve solenoid circuit trouble (TG only)
- Water flow switch circuit trouble
- System low water pressure
- System isolating valve closed
- Control panel primary power failure

A pair of normally open contacts is provided in the appropriate control panel for TROUBLE and FIRE conditions for each preaction sprinkler system. The contacts are designed to close upon receipt of these conditions and are used to initiate alarms in the CR (Section 9.5.1.2.19.12).

The switchgear rooms are protected by manually-actuated preaction sprinkler systems. The fire detectors are ionization, spot-type smoke detectors. The local panels continuously monitor the rooms and activate alarm bells at the panels upon indication of fire.

The off-normal conditions include:

- Loss of supervisory air pressure
- Opening of OS&Y isolation valve
- High pressure downstream of OS&Y (indicating water leakage/flow past OS&Y)

Local manual isolation valves are provided in the hallway adjacent to the switchgear rooms to control the water supply to the switchgear room preaction sprinkler systems. When the isolation valve is opened, water is admitted to the system and discharges from any sprinkler heads that open.

A supervisory air system is provided to monitor the integrity of the switchgear room preaction system. In the event of the loss of system air pressure, a low pressure signal is annunciated in the CR.

9.5.1.2.19.5 Preaction Sprinkler System (Automatic) - Areas protected by the automatic preaction sprinkler systems include, but are not limited to the DGB engine rooms and the Lighting Diesel Generator Building. Control panels continuously monitor the fire detection systems associated with each preaction sprinkler system.

Two complete detection circuits are provided for each system to protect the DGB engine rooms and the Lighting Diesel Generator Building. The fire detectors used are thermostatic, spot-type heat detectors with rate compensation. The two detection circuits utilize the cross-zone principle, by which, upon receipt of an indication of fire from one detection circuit, a control panel will annunciate a FIRE ALERT. Upon receipt of an indication of fire from both detection circuits concurrently, a control panel automatically opens the electrically actuated deluge valve that controls the water supply to the appropriate preaction sprinkler system. Water is then admitted to the system and discharges from any sprinkler heads that open.

The appropriate panel also activates a fire alarm bell local to the protected area. A visible indication is provided on the panel to show which system is indicating a fire alarm. A WATER FLOWING alarm is also provided. Upon receipt of this alarm, the operator is assured that the deluge valve has operated. The operator may then determine if water is being discharged through the sprinkler heads by attempting to reset the alarm. The resetting of the alarm indicates no water discharge; inability to reset indicates sprinkler operation.

In addition to monitoring for fire conditions, the panels monitor other conditions necessary to ensure the availability and proper operation of each detection and preaction sprinkler system. Upon receipt of any off-normal condition, visible and audible indications of the trouble are provided at the panel.

The off-normal conditions include:

- Detection circuit(s) trouble
- Deluge valve solenoid circuit trouble
- Water flowing switch circuit trouble
- System low water pressure
- System isolating valve closed
- Control panel primary power failure
- Low supervisory air pressure (DGB only)

A pair of normally open contacts is provided in the appropriate control panel for TROUBLE and FIRE conditions for each preaction sprinkler system. The contacts are designed to close upon receipt of these conditions and are used to initiate alarms in the CR (Section 9.5.1.2.19.12).

9.5.1.2.19.6 Water Spray Fixed Systems - A list of equipment/areas protected by water spray fixed systems actuated either automatically or manually is provided in Table 9.5-3. The fire detectors used to actuate water spray systems protecting cabling areas outside Containment are fixed-temperature, line-type heat detectors, laid in a sine-wave pattern on top of cables in the cable tray within the protected zone. In these cabling areas outside Containment, ionization-type smoke detectors are also installed for early detection of a fire. Manual actuation is used to actuate water spray systems protecting cabling areas inside Containment.

The fire detectors used for water spray systems protecting hazards other than cabling areas are thermostatic, spot-type heat detectors with rate compensation or continuous thermistor type in the case of HVAC carbon filters.

Control panels continuously monitor the fire detection system associated with each of the water spray fixed systems. Upon receipt of an indication of fire from any detector, the appropriate control panel automatically opens the electrically actuated deluge valve that controls the water supply to the spray system associated with that detector. The panel also activates a fire alarm bell local to the protected area. A visible indication is provided on the panel to show which system is indicating a fire alarm. The HVAC carbon filters deluge valves and RCB cable tray deluge valves are manual-electrically actuated.

In addition to monitoring for fire conditions, the panels monitor other conditions necessary to ensure the availability and proper operation of each detection and water spray system. Upon receipt of any off-normal condition, visible and audible TROUBLE indications are provided at the appropriate panel.

The off-normal conditions include:

- Detection circuit trouble
- Deluge valve solenoid circuit trouble
- Water flowing switch circuit trouble
- Manual fire alarm switch circuit trouble
- System low water pressure (except RCB)
- System isolating valve closed
- System isolating valve open (HVAC carbon filters only)
- Control panel primary power failure

A pair of normally open contacts is provided in the appropriate control panel for TROUBLE and FIRE conditions for each water spray fixed system. The contacts are designed to close upon receipt of these conditions and are used to initiate alarms in the CR (Section 9.5.1.2.19.12).

9.5.1.2.19.7 Standpipe Systems (Wet) - A list of areas protected by standpipe systems is provided in Table 9.5-3. These systems are manual and normally wet, and there is no automatic action required from a local control panel for these systems to be operated.

Control panels do, however, monitor conditions necessary to ensure the availability and proper operation of each system. Upon receipt of any off-normal condition, visible and audible TROUBLE indications are provided at the appropriate panel.

The off-normal conditions include:

- System isolating valve closed

- System low water pressure

- Control panel primary power failure

A pair of normally open contacts is provided in the appropriate control panel for TROUBLE conditions for each wet standpipe system. The contacts are designed to close upon receipt of these conditions and are used to initiate alarms in the CR (Section 9.5.1.2.19.12).

9.5.1.2.19.8 Preaction Standpipe Systems (Manual) - A preaction standpipe system is provided to protect the RCB. The system is normally supplied with water from the MAB internal ring main. Thermostatic spot-type heat detectors are provided for the RCPs and fixed temperature line type heat detectors are provided in the cable trays.

A control panel continuously monitors the fire detection systems provided in the RCB. Upon receipt of an indication of fire, the control panel activates a fire alarm bell local to the protected area. A visible indication is provided on the panel indicating a fire alarm.

The supply of water to the standpipe system is controlled by a motor-operated outside Containment isolation valve. The MOV is remote-manually controlled from the CR and receives a Containment isolation signal for automatic closure.

The panel also monitors other conditions necessary to ensure the availability and proper operation of the standpipe system. Upon receipt of any off-normal condition, visible and audible TROUBLE indications are provided at the panel.

The off-normal conditions include:

- System isolating valve closed

- Control panel primary power failure

- System pressurized

- Detection circuit trouble

A pair of normally open contacts is provided in the control panel for TROUBLE and FIRE conditions for the preaction standpipe system. The contacts are designed to close upon receipt of these conditions and are used to initiate alarms in the CR (Section 9.5.1.2.l9.l2).

9.5.1.2.19.9 Foam Extinguishing Systems - The AFOST is protected by the foam extinguishing system. The fire detectors used are thermostatic, spot-type heat detectors with rate compensation. These detectors are located around the periphery of the tank.

A control panel continuously monitors the fire detection system associated with the foam extinguishing system. Upon receipt of an indication of fire from any detector, the control panel automatically opens the electrically actuated deluge valve that controls the water supply to the foam system associated with that detector. The panel also activates a fire alarm bell local to the protected area. A visible indication is provided on the panel to show that the system is indicating a fire alarm.

In addition to monitoring for a fire condition, the panel monitors other conditions necessary to ensure the availability and proper operation of the detection and foam system. Upon receipt of any off-normal condition, visible and audible TROUBLE indications are provided at the panel.

The off-normal conditions include:

- Detection circuit trouble
- Deluge valve solenoid circuit trouble
- Water flowing switch circuit trouble
- Manual fire alarm switch circuit trouble
- System low water pressure
- System isolating valve closed
- Control panel primary power failure

A pair of normally open contacts is provided in the control panel for TROUBLE and FIRE conditions for the foam system. The contacts are designed to close upon receipt of these conditions and are used to initiate alarms in the CR (Section 9.5.1.2.19.12).

9.5.1.2.19.10 Foam-Water Sprinkler Systems - The areas protected by the foam-water sprinkler systems are the DGB fuel oil tank rooms. The fire detectors used are thermostatic, spot-type heat detectors with rate compensation. Two complete and independent detection circuits are provided for each system. The two detection circuits in each room are wired and arranged in a cross-zoned configuration, located at the ceiling level. Failure of any detector to operate will not affect the operability/functional capability of any other detector, and the failure of one circuit will not affect the alternate circuit.

Control panels continuously monitor the fire detection systems associated with the foam-water sprinkler system. Upon receipt of an indication of fire from any detector, the appropriate control panel automatically opens the electrically actuated deluge valve that controls the water supply to the foam-water sprinkler system associated with that detector. The panel also activates a fire alarm bell local to the protected area. A visible indication is provided on the panel to show which system is indicating a fire alarm.

In addition to monitoring for fire conditions, the panels monitor other conditions necessary to ensure the availability and proper operation of each detection and foam-water sprinkler system. Upon receipt of any off-normal condition, visible and audible indications are provided at the appropriate panel.

The off-normal conditions include:

- Detection circuit(s) trouble
- Deluge valve solenoid circuit trouble
- Water flowing switch circuit trouble
- Manual fire alarm switch circuit trouble
- System low water pressure
- System isolating valve closed
- Control panel primary power failure

A pair of normally open contacts is provided in the appropriate control panel for TROUBLE and FIRE conditions for each foam-water sprinkler system. The contacts are designed to close upon receipt of these conditions and are used to initiate alarms in the CR (Section 9.5.1.2.19.12).

9.5.1.2.19.11 Halon l30l System - The areas protected by Halon 1301 systems are the relay portion of the CR, the plant computer room, Battery Room 215A, and the TSC computer room. The detection system provided for the relay portion of the CR and the plant computer room are of the cross-zone type, using ionization spot-type smoke detectors. The subfloor areas of the plant computer room and Battery Room 215A are also provided with cross-zone detection using ionization spot type smoke detectors. The TSC computer room and subfloor are provided with detection using ionization spot type smoke detectors.

Control panels continuously monitor the fire detection systems associated with each Halon 1301 system. Upon receipt of an indication of fire from a single ionization detector, the control panel annunciates a FIRE ALERT. Upon receipt of an indication of fire from a detector in the other zone, the control panel automatically opens the electrically actuated solenoid valve controlling the Halon 1301 supply to the appropriate system and initiates the closing of HVAC dampers in the affected room. In addition, the panel also activates an alarm/evacuation bell within each area flooded by Halon. A visible indication is provided on the panel to show which system is indicating a fire alarm. Manual fire alarm switches are provided outside each of the protected areas to permit manual-electric operation of the Halon 1301 system.

In addition to monitoring for fire conditions, the panels monitor other conditions necessary to ensure the availability and proper operation of each detection and Halon 1301 system. Upon receipt of any off-normal condition, visible and audible indications are provided at the panel.

The off-normal conditions include:

- Detection circuit(s) trouble
- Low Halon l30l cylinder pressure (relay area of CR and computer rooms only)
- System discharged
- Halon flow switch circuit trouble
- Control panel primary power failure
- Solenoid valve circuit trouble
- Damper solenoid circuit trouble
- Manual fire alarm switch trouble

A pair of normally open contacts is provided in the appropriate control panel for TROUBLE and FIRE conditions for each Halon 1301 system. The contacts are designed to close upon receipt of these conditions and are used to initiate alarms in the CR (Section 9.5.1.2.19.12).

9.5.1.2.l9.l2 Data Acquisition System - Alarm, trouble, and system status signals generated by the local control panels are transmitted to the plant main CR for display and recording. The local control panels utilize a redundant loop configuration to transmit alarm information to the data acquisition system.

The data acquisition system includes a central processing unit, and display screen. The data acquisition system monitors each local control panel which in turn monitors the fire detection devices located within the plant. A TROUBLE or FIRE condition is reported to the data acquisition system via the redundant loop. Receipt of this signal creates a message on the display screen located in the main control room. A corresponding message is archived and can be printed upon request.

Operators within the control room have the ability to check the status of any alarms in any fire zone or to request a printout of alarm messages.

Data communications will be provided from the Reservoir Makeup Pumping Facility fire detection panel, to the data acquisition system located within the control room.

9.5.1.3 Safety Evaluation. The Fire Protection System is seismically designed to retain structural integrity without structural collapse and subsequent damage to safety-related structures and equipment.

The FMEA for the Fire Protection System is provided in Table 9.5-1.

9.5.1.4 Inspection and Testing Requirements. Fire Protection Systems are installed, inspected, and acceptance tested in accordance with the requirements of a QA program which has been implemented by Houston Lighting & Power (HL&P) (historical context) and by contractors which supply engineered equipment or systems. These programs include the ten elements suggested by APCSB 9.5-1 Appendix A, Section C as they apply to the design, installation, and testing of engineered fire protection systems and components. Extended QA programs are not applied to standard commercial UL-listed and/or Factory Mutual approved items.

9.5.1.5 Qualifications. The resumes of the fire protection engineers who performed the fire hazard analysis are contained in the FHAR.

9.5.1.6 Fire Protection Program. The South Texas Project Electric Generating Station (STPEGS) Fire Protection Program establishes the policy for the protection from fire of life, structures, and equipment. The program emphasizes the protection of safety-related structures, systems, and components and utilizes a defense-in-depth approach to ensure the ability to safely shut down the plant in the event of a fire.

Procedures have been written to describe the equipment, personnel, and organizational responsibilities and authority for fire protection program implementation. A summary of the delegation of responsibilities for certain portions of the program is given below.

1. The President & Chief Executive Officer is the management position which has overall responsibility for the formulation, implementation, and assessment of the effectiveness of the STPEGS Fire Protection Program.

2. The effectiveness of the STPEGS Fire Protection Program including drills and training, will be periodically evaluated by the appropriate organizational unit. The results of these assessments shall be reported to responsible management with recommendations for improvements or corrective actions as necessary.

3. The Plant General Manager is the onsite management position responsible for overall administration of the Fire Protection Program.

4. The Engineering General Manager is the onsite management position responsible for the administration of Fire Protection Engineering.

5. Responsibility for implementation of the Fire Protection Program has been delegated to the Fire Marshal. The Fire Marshal is an individual knowledgeable through education, training, and/or experience in fire protection and nuclear safety. Other personnel are available to assist the Fire Marshal as necessary.

6. The Fire Marshal has been delegated responsibility for development and administration of the Fire Protection Program including administrative controls, periodic fire prevention inspections, fire protection systems/equipment inspections and testing, evaluations of work activities for transient fire loads, identification of fire protection training requirements, and prefire planning.

7. Responsibility for the implementation of the fire protection training has been delegated to the Fire and Safety Specialist. The Fire and Safety Specialist is responsible for developing, scheduling, and presenting fire protection training in accordance with the requirements of the Fire Protection Program.

8. The Manager, Quality is the onsite Quality Assurance position responsible for developing the quality assurance program for the Fire Protection Program.

Personnel with operations phase fire protection duties shall possess the following minimum qualifications.

1. The Fire Marshal, or a person available to him for consultation, shall be a graduate of an accredited engineering or fire science curriculum and shall have a minimum of six years applicable experience, three of which shall have been in the area of fire protection engineering. Education and/or experience acceptable to the Society of Fire Protection Engineers for membership as a professional practice grade member, may be considered as equivalent qualifications.

2. The fire brigade leader and brigade members shall pass a physical examination for performing strenuous activity and shall be trained in accordance with the training program described below.

3. Instructors for fire protection training programs shall be qualified by education, training, and/or experience in the subject(s) being taught.

NFPA 27 (1975) and other NFPA standards, as appropriate, are used for information and guidance in developing and implementing the Fire Protection Program.

9.5.1.6.1 <u>Administrative Controls</u>: Administrative controls are implemented to ensure the acceptable performance of fire protection systems and personnel. These controls are included in plant procedures and provide for the following:

1. Bulk storage of combustible materials is prohibited inside of, or adjacent to, safety-related buildings or systems except in designated storage areas for which adequate fire protection is provided.

2. The use and handling of ordinary combustibles (including filter media, ion exchange resins, wood, or other combustible supplies) and combustible and flammable liquids and gases are controlled.

3. Waste, debris, scrap, oil spills, and other combustibles which constitute a fire hazard resulting from work activities are removed as soon as practicable following completion of the activity or at the end of the work shift, whichever comes first.

4. Ignition sources are controlled by use of a hot work permit system.

5. Open flames or combustion generated smoke are not used for leak testing.

6. The plant equipment clearance order procedure is used for removing fire protection systems from service.

7. Periodic inspections and testing as described below are performed to ensure compliance with administrative controls and to ensure the operability/functional capability of fire protection systems.

8. Instructions are provided concerning actions to be followed by individuals discovering fires.

9. Guidelines are provided for the actions of CR operators and the fire brigade. These guidelines include fire preplans for safety-related areas and areas presenting a hazard to safety-related equipment.

The operability/functional capability of fire protection systems required to protect safe shutdown capability is assured through the implementation of an administrative program equivalent to the requirements of DRAFT Revision 5 of NUREG-0452 as outlined below. This program includes testing requirements, compensatory actions for systems out of service, fire brigade staffing, and Quality audits of program implementation. It covers those systems, including suppression systems, detection systems, and fire barriers, which are identified in the FHAR as protecting areas/zones containing safe shutdown equipment or cabling.

Specifically, the Fire Protection Program provides a level of protection equivalent to the following sections of DRAFT Revision 5 of Westinghouse Standard Technical Specification, NUREG-0452, with clarification as necessary:

1. 3/4.7.11.1- Fire Protection Water Supply and Distribution System. With regard to monthly starting and operation of the fire pumps, STPEGS does not need to operate on recirculation flow since the diesel drivers utilize water from the pump discharge for engine cooling. The flow requirements of the fire protection systems protecting safe shutdown capability can be met with a single pump; therefore, the Fire Protection Program only requires 2 out of 3 operability/functional capability for these pumps.

   STPEGS has no valves, considered to be automatic actuating, in the flowpath upstream of sprinkler/spray system isolation valves. Therefore, the use of the terminology "automatic valves", as described in 4.7.11.1.1.f.1, is not included in the STPEGS Fire Protection Program.

2. 3/4.7.11.2 - Spray and/or Sprinkler Systems: no clarification required.

3. 3/4.7.11.4 - Halon Systems: no clarification required.

4. 3/4.7.11.5 - Fire Hose Stations: no clarification required.

5. 3/4.7.11.6 - Yard Fire Hydrants and Hydrant Hose Houses: Only the fire hose house associated with yard fire hydrant #13 is included in the operability/functional capability programs described above. All other inspections of hydrant hose houses for required equipment are performed as a good practice. However, since the fire brigade response vehicle contains hose and nozzles, the inspection of all fire hydrant hose houses is not included in the

operability/functional capability program for protection of safe shutdown capability described above.

6. 3/4.7.12 - Fire Rated Assemblies: no clarification required.

7. 3/4.3.3.8 - Fire Detection Instrumentation: Fire detection instruments shall be functionally tested at least once every 12 months, except visual flame detectors which shall be tested at least once every 6 months.

8. 6.2.2 - Unit Staff (in the Technical Specifications).

Other fire protection systems and equipment are not included in the administrative or QA programs described above; however, operability/functional capability testing of a similar nature is conducted as necessary for property protection and personnel safety reasons. The need for compensatory actions is evaluated on a case-by-case basis.

9.5.1.6.2 Fire Brigade: A five-member fire brigade is maintained on each shift. Members of the Plant Operations shift crew typically serve as Fire Brigade leaders and as members. These employees receive annual physical examinations for strenuous activity and are given training on safety-related systems and other systems as necessary.

Fire brigade members are provided with protective equipment as described below:

1. Turnout gear including bunker coat, pants, boots, gloves, helmet, and self-contained breathing apparatus (SCBA). At least ten SCBAs with full-face positive-pressure masks are available for fire brigade personnel.

2. Portable lights

3. Communications equipment

4. Ventilation equipment

5. Portable extinguishers

At least one hour of extra air in bottles is available onsite for each of the ten SCBAs. In addition, a sufficient supply of air is maintained onsite to supply the five-man fire brigade for six hours.

The fire brigade training program includes initial training, periodic retraining, and fireground practice sessions. Additional information concerning fire protection training, including fire brigade training, general employee training, training for offsite fire departments, and contractor/temporary employee training is provided in Section 13.2.2.

Each shift fire brigade conducts planned quarterly meetings to review changes in the fire protection program, plant modifications, changes in fire preplans, and other related subjects of interest.

Drills are conducted quarterly for each shift fire brigade. Watch station assignments are considered in planning drills in an effort to ensure that each fire brigade member participates in at least two drills per year. Additional information concerning frequency, purpose, and content of drills is provided in Section 13.2.2.

The Fire Marshal critiques fire drills. Critiques of drills are documented and performance deficiencies are remedied by additional training and/or repeat drills within 30 days as deemed necessary by the Fire Marshal.

Records of fire brigade training and drills are maintained for a minimum of three years.

An overall assessment of the Fire Protection Program is performed by qualified individuals independent of STPEGS at least once every three years. These assessments are performed under the cognizance of the Senior Management Team as described in Chapter 19.0 of the Operations Quality Assurance Plan (OQAP).

9.5.1.6.3 Quality Assurance Program: The Operations Quality Assurance Plan (OQAP) ensures that regulatory requirements and commitments concerning fire protection are satisfied during plant operations.

9.5.2 Communications Systems

9.5.2.1 Design Basis. The Communications System is designed to facilitate rapid, efficient operation and administration of the plant during normal and emergency conditions. Diverse subsystems are supplied to assure that adequate onsite and offsite communications will be available to support orderly plant shutdown and evacuation. Steps are taken to provide backup power and to assure audibility in high-noise areas of the plant serviced by the various systems. Special attention is given to maintaining offsite contact with the Matagorda County Sheriff's Office, the Bay City Fire Department, and the CenterPoint Energy Control Center in Houston.

9.5.2.2 Description. Communication systems serve during all modes of plant operations and maintenance including all levels of emergency conditions. The following are provided:

1. Telephone System

2. Public Address System/Alarm System

3. Maintenance Jack System (DC/sound powered headsets)

4. Refueling Communication System

5. Two-Way Radio System

6. Radio Pager and Cellular Phone Texting System

7. Digital Integrated Communications Electronic System

9.5.2.2.1 Onsite Systems:

1. Telephone Systems - The telephone system consists of an onsite telephone switch, private business lines, and trunk connections with the local telephone utility central office, and multiplexed telephone circuits through the CenterPoint Energy private regional microwave system. The onsite telephone switch consists of two separate electronic switches. Switch No. 1 is located in the Nuclear Support Center (NSC), a building located east of Unit 1. Switch No. 2 is located in the Nuclear Training Facility (NTF) building. Both switches are interconnected with fiber optic cable in addition to trunk connections with the local telephone utility central office.

   Telephone instruments are distributed throughout the plant facilities for operating convenience. Instrument distribution is designed to load each switch with one-half the emergency or essential telephones in any given power block area. Therefore, some emergency or essential telephones in any one area will be operable in the event of a major failure of either switch.

   Both of the switches are powered by an individual 8-hour battery system. These battery systems are charged by offsite 120 vac backed up by the NTF or NSC diesels. Loss of normal 120 vac and low battery voltages is annunciated.

   Each switch provides many standard system features. Single-line telephones are afforded access to many of these operational features.

   Telephones located in some high-noise areas (90-db ambient) are installed with wraparound noise-reducing telephone booths. Also, noise-canceling handsets and headsets are provided in high-noise areas where required.

   The offsite telephone system access is provided through the local telephone utility central office. Private business lines from the central office terminate at designated plant instruments which bypass the onsite telephone switch. Additional offsite telephones bypass both the telephone switch and the local utility central office. These telephones are provided with access to the CenterPoint Energy private microwave network. This network provides PBX gateways distributed throughout the CenterPoint Energy regional private telephone system. This includes the CenterPoint Energy Control Center in Houston.

2. Public Address System/Alarm System - Centralized 70.7-volt output public address racks are provided in the EAB. The public address system may be accessed from any Operator Communications Panel (OCP) or any plant telephone by using a valid authorization code or a valid Number Class of Service. The control rooms have priority access to the public address system. Selected areas or the entire plant may be paged by using an OCP.

   Speakers are divided between amplifiers for reliability, and are located in all areas where operating and maintenance personnel may be working. Sufficient amplifier power is provided to assure audibility over most anticipated maximum plant noise levels. Automatic gain amplifiers are used to adjust individual amplifier output in accordance with noise levels sensed by microphones in the areas served.

   Normal power for the public address system is from normal plant 120 vac sources. A non-Class 1E diesel backup is available during emergency conditions.

Plant emergency and fire alarm signals are routed through the public address system. Designated alarm actuation pushbuttons are provided on OCPs. These alarms have priority over other paging. In areas where noise levels are too high for audible alarms to be heard, flashing lights are supplied in addition to audible alarms for emergency warning.

3. Maintenance Jack Communication System - Maintenance jacks are provided throughout the plant for operating convenience, including all areas required for safe shutdown. Each jack station consists of three or four jacks. These jacks are powered by 8 vdc for use with electrosound telephones except the last jack position, which is reserved for sound powered telephones.

   A sectionalizing panel is provided in the EAB to interconnect jack loops between the various plant buildings. Inoperable loops can be identified and quickly isolated using this panel. In high noise areas (greater than 90 db ambient), noise-cancelling headsets are provided for use with the Maintenance Jack System.

4. Refueling Communications System - Primary communications for fueling and refueling activities will be by wireless headset system between the control room operator and designated points in the FHB and the RCB. Two DC-powered jacks and a sound-powered circuit similar to the maintenance jacks are available at each station for backup. Telephone circuits and two-way radios are also usable if needed for refueling communications.

5. Two-Way Radio System - Primary, high power, radio repeater base stations and antennas operating in the 450 MHz band provide communication between control base stations, mobile units, and hand-held portables. Primary repeater base stations are powered by normal plant 120 vac power backed up with a non-Class 1E DG. Mobile radios are powered by vehicular batteries. Hand-held portables are powered with self-contained batteries.

   In the event of major failure of any repeater, a talk-around channel is provided on control base stations, mobile units, and hand-held portables. This allows limited direct unit-to-unit communication between control bases, mobile units, and portables. Portables that must be used in high noise level areas (90 db ambient) are provided with a jack, plug, and noise-cancelling headsets.

   A lossy loop antenna system is provided for required radio coverage within power block structures. This antenna system makes possible radio propagation into and out of these buildings where otherwise the mass of building material would block radio propagation. The lossy loop antenna system is constructed of base station repeaters, two-way broad-band/in-line repeaters, coaxial cable, voting receivers, leaky loss coaxial cable, inside building antennas, and conventional outside antennas.

   Two selected lossy loop ultra high frequency (UHF) channels are provided with alternate repeater base stations in the EAB communications room. These alternate base stations assure communication within the power block should the primary, high power repeater base fail. Backup non-class 1E power to the lossy loop alternate repeater base stations, voting receivers, radio consoles, and two-way repeaters is provided by a DG located in a secured vital area. CN-3118

Uninterruptible Power Supply (UPS) cabinets maintain continuous communication during transition from primary power to DG.

Radio set-up facilities for outside agencies are provided at the EOF. Outside agencies providing their own high frequency (HF)/very high frequency (VHF)/UHF radio systems are provided with work station countertop and desk space, normal facility 120 vac power backed up with a non-Class 1E natural gas generator, and a self supporting tower for mounting antennas.

6. Radio Pager and Cellular Phone Texting System- A VHF radio pager system is used to page individuals and groups carrying portable receivers inside the power block. Cellular phones are used to notify and inform individuals and groups carrying designated cell phones outside the power block. A group or individual paging call can be initiated from any voice device via the paging terminal. VHF paging coverage is provided within the power block using the lossy loop antenna system.

   Group pages and group texts can be initiated using an off-site hosted server or a site backup server. This method can be initiated by designated individuals or authorized groups.

   The radio paging transmitter, countertop paging terminal, and site backup server are powered by normal plant 120 vac backed by a generator. The pocket pager units and cellular phones are supplied with a self-contained battery.

7. Digital Integrated Communications Electronic System - OCPs provide plant operators with access to onsite/offsite telephone systems, two-way radio channels, radio pager system, activation of the plant emergency and fire alarm signals, and the public address system. The OCPs are powered with normal plant 120 vac and backed up with non-Class 1E DGs and an 8-hour battery, except the OCP in the EOF which is powered from normal commercial power and is backed up by a natural gas generator. OCPs are provided in both control rooms, both TSCs, the EOF, both auxiliary shutdown panels, the training facility, and other areas as needed.

   The OCPs located in the central and secondary alarm stations support normal day-to-day and emergency communications requirements by providing security operators with access to onsite/offsite telephone systems, radio channels assigned to security, and the public address paging system.

   Operators at each OCP may select various modes of operation including monitor only, talk/listen, or off for any two-way conversation loop. OCP operators communicate using headsets or hand sets.

   The operator uses OCP touchscreen to select channels, to select automatic-ring-down telephone hot lines, to interface channels for conferencing, to monitor single channels, or to monitor more than one channel simultaneously.

9.5.2.2.2 Offsite Communication Systems: Offsite communications are provided by Verizon Telephone circuits and the CenterPoint Energy microwave system. Telephone circuits have access to the telephone switching network in Palacios, Texas, while the microwave system provides a direct link to the CenterPoint Energy Control Center in Houston. Direct lines to the Palacios central office such as hot lines, dedicated business, and data lines are distributed from the plant main distribution frame. These special lines are not routed through PBX circuits.

9.5.2.2.3 Emergency Communication Systems: Emergency communications for the STPEGS are dealt with expressly in the Emergency Plan. The communications system has been designed to allow contact among plant personnel and plant-to-offsite communications during normal and all emergency conditions.

During normal conditions with all equipment in service, the following systems are available:

1. A telephone switch, with dial access to trunks to Verizon Telephone in Palacios and Houston (also, dial access to the plant public address system and the radio pager system)

2. Direct (automatic or code ring) telephones to the CenterPoint Energy Control Center in Houston and the Matagorda County Sheriff's Office

3. Palacios business telephones4. Two-way radio system

5. Maintenance Jack Communication System

In the event the EPBX system is disabled, operating personnel have the following systems available:

1. Direct access to the plant voice paging system from the control room

2. The radio system, accessed from the control points in the control rooms and the security office, mobile units, or hand-held portables

3. All special service telephones, such as the NRC’s Emergency Notification System and Health Physics Network, and data and direct lines

4. All Palacios business telephones

5. Refueling Communication System

6. Maintenance Jack Communication System

7. Hand-held portable radios

Other possible conditions include:

1. Loss of the microwave system removes the dial access circuits to Houston, along with the direct telephones, leaving private lines available.

2. In the event that radio repeaters for all frequencies are lost, the radios operating mobile-to-mobile, portable-to-mobile, or portable-to-portable are available.

3. In the event power is lost on the Maintenance Jack Communication System, sound-powered sets are used instead of the 8 vdc hand sets or headsets.

The bulk of the communications subsystems are used in normal plant operations providing an ongoing test of the systems. Additionally, all onsite and offsite communications systems are tested periodically to verify operability. Maintenance logs are maintained and are updated by technicians responsible for each type of communications equipment in use.

Spare parts for communications systems are securely stored near the equipment requiring such parts. Special tools or test equipment required for each system are on the plant site for use by the technicians. Cables for the telephone switch, paging systems, other in-plant telephone systems, microwave channels, and radio systems are terminated in each building in such a manner as to permit ease in testing and troubleshooting. Alarms indicate abnormalities in any of the communications systems and service personnel are dispatched to correct identified faults. A current list of all technicians' business and home telephone numbers, as well as cellular mobile numbers, is maintained in the CR.

9.5.2.2.4 System Operation Communication Stations: Table 9.5.2-1 identifies working stations in the plant where it may be necessary for plant personnel to communicate with the CR or the auxiliary shutdown panel during and/or following accidents (including fire) to mitigate the consequences of the event and attain a safe cold shutdown.

9.5.2.3 Inspection and Testing. Preventive maintenance activities and operability checks necessary to ensure reliable operation of site emergency communications have been developed. These activities may be revised based upon evaluation of factors such as plant operating experience, industry experience, and vendor recommendations.

9.5.3 Plant Lighting Systems

9.5.3.1 Design Bases

1. The Lighting System is designed so that a single failure of any electrical component, assuming loss of offsite power (LOOP), will not terminate the system's ability to illuminate those areas where, during emergency conditions, reactor shutdown is carried out.

2. The lighting subsystems that serve the main CR, the remote shutdown areas and the access/egress routes thereto, and other areas in which the collapse of the Lighting System would physically impact on Class 1E equipment are seismically supported to prevent their collapse during and after a Safe Shutdown Earthquake (SSE). The Lighting System supports for equipment and raceway in close proximity to Category I equipment are designed for seismic concerns, and to prevent structural collapse during and after an SSE.

3. Lighting fixtures containing mercury lamps and mercury switches are not used inside the RCB, specific MAB areas, and FHB. However, mercury is used in a mercury/sodium amalgam for temporary underwater lights used during refueling activities for the Reactor Cavity and for permanent underwater lights for the Spent Fuel Pool and the Fuel Transfer Canal.

Lighting fixtures with lamps containing mercury, if used in the TGB over the turbine or portions of the secondary system which can be opened during maintenance operations, and over the condensate polishing demineralizer regeneration equipment area, are provided with solid translucent lamp guards to prevent falling lamps. All MAB lighting fixtures with lamps containing mercury are provided with solid translucent lamp guards.

The above restrictions also apply to sodium-vapor lamp fixtures.

The design of the integrated Lighting System is based upon the applicable portions of the following codes and standards:

- Illumination Engineering Society (IES) Lighting Handbook (1972)
- Occupational Safety and Health Standards (OSHA) 29CFR1910
- National Electric Code (NEC) NFPA 70-1981
- Federal Aviation Administration (FAA) Obstruction Marking and Lighting - Advisory Circular No. 70/7460-IF, dated September 27, 1978

9.5.3.2 System Description. The Lighting System provides illumination for normal and emergency plant operations, and access/egress routes for fire-fighting and safe building evacuation.

The Lighting System is comprised of three separate systems as follows:

1. Normal AC Lighting
2. Essential AC Lighting
3. Emergency DC Lighting

9.5.3.2.1 Normal AC Lighting System: The Normal AC Lighting System provides the major portion of the illumination requirements throughout the plant. This system also provides power for the 120 V convenience receptacles.

Power for this system is supplied from the non-Class 1E System. If this power is not available, power for the yard area lighting is provided from a non-Class 1E DG (shared between units).

Under normal operating conditions, the Normal AC and Essential AC Lighting Systems operate together to provide lighting for the plant.

9.5.3.2.2 Essential AC Lighting System: The Essential AC Lighting System provides the illuminating requirements for the safe shutdown areas, other operating areas, and access/egress routes. A minimum of ten footcandles is provided at the work stations in the safe shutdown areas which are:

1. CR

2. Auxiliary Shutdown Panel

3. Transfer Switch Panels as defined in Section 7.4.1.9.2

4. Standby Diesel Generator Control Panels

5. Chiller Control Panels

6. Boric Acid Tank Room

7. Component Cooling Water Surge Tank

Two to five footcandles are provided in the access/egress routes between the above work stations, within buildings.

Power for the Essential AC Lighting System is supplied from two Class 1E and one non-Class 1E system. Upon loss of the normal power supply (i.e., LOOP) the Essential AC Lighting System is automatically connected to the Class 1E (trains A and C) and the non-Class 1E (TSC, 1 per unit) DGs. The lighting power sources for the safe shutdown areas and access/egress routes are shown in Table 9.5.3.1.

9.5.3.2.3 Emergency DC Lighting System: The Emergency DC Lighting System consists of lighting supplied from batteries upon loss of the Normal and Essential AC Lighting Systems.

The Emergency DC Lighting System provides illumination at safe shutdown areas including access/egress routes between them, and at the access/egress routes to and from fire areas during fire transients, and accident conditions as follows:

1. The 8-hour sealed beam battery packs are supported to withstand an SSE. They are mounted in the safe shutdown areas as listed in Section 9.5.3.2.2, and in the access/egress routes between them, within buildings. 10CFR50 Appendix R safe shutdown areas and their access egress routes are also equipped with 8-hour sealed beam battery packs.

2. The TSC also uses 8-hour battery packs.

3. Lighting from sealed beam lights with at least 90-minute battery packs is provided in other access/egress routes upon loss of normal area lighting.

4. The EOF is in an off-site leased facility, so the emergency lighting is powered by commercial grade battery packs for ingress/egress compliant with local codes.

The Emergency DC Lighting System is a backup to the primary emergency lighting system (Essential AC Lighting) and does not necessarily meet the IES 1972 guideline illumination level requirements that the Essential AC Lighting System provides.

9.5.3.3 Safety Evaluation. An integrated lighting system consisting of Normal AC Lighting backed up by Essential AC Lighting (powered by Class 1E ESF DG's trains A and C and non-Class 1E TSC DG), which is further backed up by 8-hour battery packs (Emergency DC Lighting System) is provided to permit the operators to shut down the unit safely and to maintain it in a safe shutdown condition at any time.

Lighting in the CR, auxiliary shutdown panel (ASP) room, transfer switch panels, and access/egress to these stations is fed from Class 1E busses. The lighting is arranged so that alternate fixtures are fed by redundant buses to maximize the coverage of remaining fixtures in the event of a loss of one Class 1E bus. Physical separation is provided to maintain independence of the redundant essential lighting systems.

If the normal (preferred) source to a Class 1E bus fails, the associated DG is started automatically. During the diesel starting period, the Emergency Lighting System provides illumination. Lighting in the CR and remote shutdown area is automatically restored during DG sequencing.

The integrated lighting system can provide adequate lighting to all vital areas (Table 9.5.3-1) from onsite power sources.

9.5.3.4 Inspection and Testing. The Emergency DC Lighting System will be subject to an annual pushbutton light operability check. For those portions of the Emergency DC Lighting System which are required to meet 10CFR50, Appendix R, the following will be performed:

1. An annual inspection of battery leads and wiring connections as recommended by the manufacturer.

2. Annual verification of proper lamp head position.

3. Replacement of batteries at a maximum of 5-years intervals or upon failure.

9.5.4 Diesel Generator Fuel Oil Storage and Transfer System

9.5.4.1 Design Bases.

1. The Diesel Generator Fuel Oil Storage and Transfer (DGFOST) System is designed to function during emergency conditions with a concurrent single active or passive failure of any one of its components.

2. The onsite storage capacity of the system provides for continuous operation of each DG at engineered safety features load requirements for at least seven days. An onsite source of replenishment is available from the Auxiliary Fuel Oil Storage and Transfer System (Section 9.5.l0). A connection is provided for replenishment from a truck from offsite sources.

3. The design of the system meets the GDCs 2, 4, 5, and 17 in addition to RG 1.137 and 1.9 as discussed in Sections 3.1 and 3.12, respectively. Also the system conforms to IEEE Standards 308-l974 and 387-l972. The equipment within the system conforms to the applicable codes and standards of the American Society of Mechanical Engineers (ASME),

American Society for Testing and Materials (ASTM), ANSI, National Electrical Manufacturer's Association (NEMA), Diesel Engine Manufacturers Association (DEMA), IEEE, American Petroleum Institute (API), NFPA, and Nuclear Engineering Liability and Property Insurance Association. Design codes of each individual component are stated in Section 3.2.

4. The safety-related portions of the system are designed to seismic Category I requirements and protected from tornado missiles by missile-proof enclosing structures. The system is designed to operate during and after the probable maximum flood (PMF).

5. The engine-mounted components are designed in accordance with the DEMA requirements and meet ANSI B31.1, N45.2, seismic Category I, and 10CFR50 Appendix B requirements. An indication of typical materials used and the margin between design pressure and working pressure for the on-engine piping is shown in Table 9.5.4-1.

6. The system is designed to accommodate periodic testing.

9.5.4.2 System Description. The DGFOST System is shown on Figure 9.5.4-1. Unit 1 is furnished with independent fuel trains, one for each standby DG. Unit 2 is identical.

Each fuel train consists of a storage tank and the necessary piping, valves, and instrumentation. A seven-day supply of fuel is maintained in the FOST for the standby DG, based upon the fuel consumption of the engine (approximately 6 gal/min). The engine-driven fuel oil primary booster pump, however, actually operates at a rate of approximately 11 gal/min. Excess fuel is returned directly to the FOST via seismic Category I, Safety Class (SC) 3 piping. The drain tank, which is non-nuclear safety (NNS) and is not required for operation, is used to collect any other excess oil (from the fuel nozzle and injector) and return it to the FOST as necessary.

The fuel oil drain tank and transfer pump are seismically supported to prevent their collapse during and after an SSE and the piping is fabricated to ANSI B31.1 requirements. The effects of fire in the DG building are addressed in the FHAR (Sections 3.4, 4.2 items F.9 and F.10). A normally isolated line is connected to the storage tank truck fill line and the Auxiliary Fuel Storage and Transfer System (Section 9.5.10). This connection may be used for replenishing the fuel used for testing the DGs. Fuel being transferred from the Auxiliary Fuel Storage and Transfer System, or from fuel trucks unloading at the diesel fuel oil ground level truck fill connection, is filtered by the Unit 1 and Unit 2 Auxiliary Fuel Oil Filtration Skid. This filtration skid consists of a prefilter, filter/water separator, final polishing filter, composite sampler, full flow recirculation line and a 200 gpm pump to overcome the pressure losses of these filters. Each Unit's filter skid is connected such that the contents of any one of the Standby Diesel FOSTs can be recycled through these filters (Figure 9.5.4-2). Each FOST is provided with a drain, vent with flame arrester, overflow truck fill line, and inspection manhole cover.

Since the elevated FOST provides the assured fuel oil supply without replenishment from the main storage tank, the operation of the system to supply fuel oil to the engine is completely passive.

The existing STPEGS arrangement is considered technically superior to an arrangement recommended by ANSI standard Nl95. Each standby DG at STPEGS has a single, elevated tank provided in a separate compartment of the DGB. During the seven-day emergency operation the system is completely passive, requiring no transfer pumps and is, therefore, more reliable. There are no buried tanks or piping in the system, thus eliminating the problem of corrosion of components by groundwater and the contamination of fuel oil by groundwater intrusion.

9.5.4.3 System Evaluation. The DGFOST System is designed to seismic Category I, SC 3 requirements. A single failure of any one FOST System component results in the failure of only one SBDG. The safe shutdown of the reactor coincident with a LOOP is achieved using the remaining two DGs. A FMEA is provided in Table 9.5.5-2.

Provisions have been made for emergency refueling in case of a flood.

For the emergency fill connection an SC 3 pipe routed through the roof to the FOST fill line is equipped with an ASME III Class 3 normally-closed valve and a quick disconnect coupling connected upstream of the valve (Figure 9.5.4-1). The quick-disconnect coupling assembly will also contain a nonsafety-related strainer. The assembly will be stored in one of the FOST rooms or with the hose in the fuel oil transfer equipment box on the roof of the Standby Diesel Generator building and will be under administrative control. A hose could then be routed to the roof via an existing hose reel for tank filling when the flood level has receded. It is considered improbable that a missile would strike the fill connection since it is only 4 inches in diameter and less than 2 ft high and is protected by the DGB roof layout. The DGFOSTs are normally filled from the auxiliary fuel oil storage tank (AFOST) rather than from the outside connections. The DGFOSTs would not require fuel oil addition in the first seven days following a tornado event and could be filled from any one of three sources (emergency fill, normal truck fill, and the AFOST) which are available. The postulation of a tornado concurrent with the design basis flood (prohibiting access) is not a credible event and is not a design basis for STPEGS.

The FOSTs are constructed of carbon steel and made to ASME III specifications. The tank is located indoors and is provided with exterior protection (painted). During operation the water content of the fuel oil will be monitored (Section 9.5.4.4) to ensure both operability of the diesels as well as to minimize corrosion of the internal fuel oil system. For these reasons, internal coatings will not be added to the FOSTs. This will alleviate any concern with peeling of internal coatings and the potential for clogging of the tank discharge. Periodic (every 31 days) drainage of water accumulation, the use of high quality fuel (water and sediment content less than 0.05 percent volume), and keeping the fuel oil tanks full except during testing, assures that internal corrosion and algae growth will be negligible.

Selection of suitable materials compatible with the type of fuel required to operate the DGs ensures that the system will not be subject to material corrosion. The basic material of construction for the piping and components in contact with fuel oil is carbon steel.

The AFOST (Section 9.5.10) will be protected by an exterior coating to reduce the possibility of corrosion. The interior is coated, except the lower 18 in., with either Ameron or Dimetcote D-3 for a thickness of 3 to 5 mils. The lower 18 in. is coated with either Amercoat no. 66 or Ameron for a thickness of 16 mils. The periodic (every 31 days) removal of water from the bottom of the tank will help minimize the possibility of internal corrosion and algae growth. Sampling and analysis for particulate matter will also be used to detect instability and oxidation of stored fuel oil which would contribute to corrosion. Appropriate actions will be taken if significant corrosion products are detected during the periodic testing.

The Steel Structures Painting Council Surface Preparation Standard, coupled with project specific requirements, will be utilized for preparation of the tank surface and application of the coating respectively.

Buried piping from the yard AFOST and from the external truck fill connection is protected from corrosion by both cathodic protection and coating. Cathodic protection is by the impressed current method. Current plans for maintenance and testing of the cathodic protection system serving the fuel oil piping include regular checks of rectifier output and periodic potential surveys. This system is nonsafety-related and the system it protects is nonsafety-related. Alternate fill connections are provided for the FOST serving the standby DGs as stated in previous paragraphs. Specifically, the truck fill and emergency fill connections will provide a backup means of filling the tank.

Fuel oil piping is routed so as not to be in the proximity of hot exhaust piping which could cause ignition of the fuel oil.

Means are provided for detecting and controlling a fuel spill. Each DG room is equipped with an instrumented drain sump. A high level alarm located in the main CR will indicate a leak (whether fuel oil, lube oil, cooling water, etc.) in the DG room. Once a leak has been detected it can be isolated external to the DG room by a shutoff valve in the FOST room, thus preventing further leakage.

The system is designed to withstand environmental design conditions, including earthquake, hurricane, and tornado loadings (Chapter 3).

Each FOST is located within a flood- and missile-proof seismic Category I compartment. Each of the three compartments is physically separated so that a failure of one fuel oil train will not affect the remaining two trains. In addition, the compartments are designed so that in the event of a fire, it will be contained within the compartment. Refer to Figures 1.2-3 and 1.2-4 for the plot plans and to the general arrangement drawing listed as Figure 1.2-10 in Table 1.2-1.

9.5.4.4 Inspection and Testing Requirements. Components of the system have been inspected and tested by the manufacturer. After installation and before initial plant operation, the DGFOST System is inspected, tested, and operated. The initial calibration frequency for the instruments associated with the diesel Fuel Oil Storage and Transfer System will be at least once every 18 months. This frequency may be revised based upon evaluations of factors such as plant operating experience, industry experience, and vendor recommendations.

Inservice inspection will be performed in accordance with ASME Boiler and Pressure Vessel (B&PV) Code, Section XI.

The properties of new and stored new fuel will be maintained in accordance with the Fuel Oil Monitoring Program.

9.5.4.5 Instrumentation Application. The three DGs are provided with independent fuel oil supply systems. Each fuel oil supply system is provided with its own instrumentation. Applicable portions of the fuel system instrumentation are designed to seismic Category I requirements, as defined in Section 3.2.

Each DGFOST is provided with level indication in the main control room, at the local panel, and locally at the tank. High-level, low-level, and low-low-level alarms are provided for each tank in the main control room. A high-level and a low-level alarm is provided at the local panel, for each tank.

The operator action required following alarm actuation is specified in the annunciator response procedures. These actions are consistent with the manufacturer's guidelines.

9.5.5 Diesel Generator Cooling Water System

9.5.5.1 Design Bases. The Diesel Generator Cooling Water System (DGCWS) is designed to circulate sufficient quantities of cooling water to dissipate heat given off by the air coolers, governor oil and lube oil coolers, and engine water jackets, under full load conditions.

The DGCWS is designed to seismic Category I and SC 3 requirements. The engine-mounted components are designed in accordance with the DEMA requirement and meet ANSI B31.1, ANSI N45.2, seismic Category I requirements, and 10CFR50 Appendix B QA (Table 9.5.4-1) with the exception of the intercoolers, expansion joints, and the piping of the Emergency Cooling Water, provided from the Essential Cooling Water System (Section 9.2.1) which are constructed to the requirements of ASME Section III, Class 3, Seismic Category I. In addition, each DG and its associated Forced-Circulation Engine Jacket Water are located in a physically separated tornado-, flood-, and missile-proof structure in the DGB, and are protected from the effects of moderate-energy line breaks.

9.5.5.2 System Description. The DGCWS consists of a Forced-Circulating Engine Jacket Water and Emergency Cooling Water. A schematic diagram for both systems is shown on Figure 9.5.5-1. Major components and design data are provided in Table 9.5.5-1.

9.5.5.2.1 Forced-Circulation Engine Jacket Water: Forced-Circulation Engine Jacket Water System is furnished for each DG to provide cooling of the engine by means of a water jacket, to cool the DG governor oil cooler and to supply heat to the combustion air, if necessary, via two air heaters/intercoolers.

This system consists of the following components:

1. Engine-driven jacket water pump

2. AC-motor-driven jacket water standby pump

3. AC-motor-driven circulation pump

4. Jacket water cooler

5. An automatic thermostatic valve

6. Jacket water standpipe

7. Combustion air heaters/intercoolers (one for each cylinder bank)

8. Electric water heater

9. Local control panel

10. Required instrumentation and piping

During normal operation, the engine-driven jacket water pump circulates water through the jacket water cooler, then through the engine water jackets, governor oil cooler, and combustion air heaters/intercoolers back to the standpipe.

The standpipe provides a reserve to compensate for minor system leakages at pump shaft seals and valve stems. There is no normal consumption of jacket water. The standpipe also serves to maintain adequate net positive suction head (NPSH) on the jacket water pumps and to provide a holdup volume for jacket water to allow for deaeration. The standpipe is approximately l6-1/2 ft. tall and holds a volume of 433 gallons. The standpipe is located on the auxiliary skid adjacent to the DG and is provided with a fill line that receives makeup water when the manual makeup valve is opened. A chemical makeup line, a drain, an overflow, and the engine discharge header complete the connections to the standpipe. A sight-glass and high/low level alarms are also furnished. The jacket water in the engine and system is initially filled with water and vented to remove the air from the system. During operation the holdup time and velocity of water in the standpipe serve to keep the jacket water deaerated and prevent formation of air pockets. Water temperature from the engine is controlled by a three-way thermostatic valve located downstream of the main pump. Water enters the valve at port "A" and at l75°F all water is directed out port "C" of the valve and through the jacket water cooler.

The three-way thermostatic valve modulates flow through ports "B" and "C" to maintain the temperature at approximately l70°F. Jacket water passing through the heater section of the combustion air heater/cooler warms the combustion air when the temperature is below the jacket water temperature and also assists in cooling the combustion air when the temperature is above the jacket water temperature.

If the engine-driven water jacket pump should fail, the AC-motor-driven jacket water standby pump will automatically start and provide the same capacity to provide jacket water to the engine. The standby jacket water pump is mounted on the auxiliary skid and is provided with a gauge on the skid gauge panel to indicate the discharge pressure. A check valve is installed downstream of this pump to prevent backflow when the pump is not operating. Automatic start of this pump occurs on low water pressure.

When the engine is not in operation, a small AC-motor-driven circulation pump, in combination with an electric water heater, maintains the Forced-Circulating Engine Jacket Cooling Water at operating temperature. A temperature switch starts the pump and turns on the heater when jacket water-temperature is l20°F falling and turns them off at l30°F rising. A check valve on the outlet side of the heater prevents a reverse flow through the pump and heater when they are inoperative.

The circulation pump and electric water heater are both powered from a 480 V Class 1E MCC. Train A MCC E1A1 powers the pumps and water heater for the Train A DG No. 11. Similarly, Trains B and C MCCs ElBl and ElCl power the pumps and water heaters for Trains B and C DGs Nos. l2 and l3, respectively. Engine temperatures are maintained at part load operation by thermostatic control of jacket water.

At 110% nominal engine load the maximum combined heat rejection for the jacket water and air intercoolers is 11,021,066 BTU/hr with a maximum 8,030,000 BTU/hr and a minimum 6,240,000 BTU/hr rejected by the jacket water cooler. The assumed heat rejection for the jacket water cooler is based on 1350 gal/min jacket water flow with full flow through the intercooler preheater and an ECW flow of 628 gal/min at a maximum design basis temperature of 106°F.

The heat load rejected to the Emergency Cooling Water under normal, full-load operating conditions is 6,240,000 Btu/hr. Based upon a closed-loop flow of l,350 gal/min entering the jacket water cooler at l70°F and an open-loop cooling water flow of 628 gal/min entering the jacket water HX at 115°F, the maximum design basis temperature of the Emergency Cooling Water.

The circulation pump motor is rated 5 hp, 460 vac, 3-phase, 60-Hz. Table 9.5.5-4 identifies the power source for the pumps and heater. Table 9.5.5-1 lists the capacity and discharge head of the pumps and rating of the jacket water heaters.

9.5.5.2.2 Emergency Cooling Water: The Emergency Cooling Water provides cooling water for the Forced-Circulating Engine Jacket Water, the lube oil cooler, and the combustion air intercoolers (one cooler per cylinder bank).

Each DG has its own separate Emergency Cooling Water, which is supplied with cooling water from separate trains of the Essential Cooling Water System (ECWS). There are no interconnections of individual trains of the Emergency Cooling Water.

During operation, full cooling water flow is supplied to all of those components serviced by the Emergency Cooling Water. The flows and heat loads for the various components are given in Table 9.5.5-1. The values are based on an ECWS supply temperature of 106°F. The total flow of the Emergency Cooling Water is 1,500 gal/min with a full load total heat load of l3,244,400 Btu/hr for Unit 1 and 13,240,614 Btu/hr for Unit 2.

9.5.5.3 System Evaluation. Each DG has an independent Cooling Water System with an independent source of water to the jacket water cooler. The DGCWS meets the single-failure criterion so that if a failure in one Cooling Water System prevents the associated DG from operating, the remaining DGs are not affected. The DG Forced-Circulating Engine Jacket Water pumps are powered from a Class 1E source. A FMEA is provided in Table 9.5.5-2.

In the event of LOOP, the ECWS will begin operation within a specific time lapse (Section 8.3) from initial startup of the DG. The time lapse will be within a safe margin of the point at which the DG would require the cooling capability of the coolers.

The DGCWS is capable of operating for a minimum of seven days without makeup from any source with the DG operating at rated load. Beyond the seven-day period makeup water can be provided if required. Sufficient instrumentation is provided to alert the operator to low water level, and adequate time is available for operator action. For these reasons, no seismic Category I system is required to provide assured makeup water for the DGCWS. Cooling water chemistry is maintained within the manufacturer's specifications. Demineralized water is used for makeup. Plant chemistry program provide instructions for the addition of the appropriate chemicals needed to preclude corrosion fouling.

9.5.5.4 Inspection and Testing Requirements. The DGCWS will be inspected and tested during the scheduled operational tests of the DGs. The cooling water in the Forced-Circulating Engine Jacket Water will be periodically analyzed and treated as necessary to maintain the desired water quality. Inservice inspection will be performed in accordance with ASME B&PV Code, Section XI.

The initial calibration frequency for the instruments associated with the diesel cooling water system (e.g., that instrumentation required to monitor cooling water temperature, pressure, and standpipe level) will be at least once every 18 months. This frequency may be revised based on evaluations of factors such as plant operating experience, industry experience, and vendor recommendations.

9.5.5.5 Instrumentation Application. The necessary controls are provided with each cooling system to maintain the engine jacket at the proper temperature for all modes of operation. Alarms are provided at the local control panel, with a common DG trouble alarm in the main CR, for low jacket water standpipe level, abnormal jacket water temperature, and low jacket water pressure at the inlet to the engine. The DGCWs indications and alarms are summarized in Table 9.5.5-3 and DG protective trips are discussed in Section 8.3.1.1.4.6. The operator action required following alarm actuation is specified in the annunciator response procedure. These actions are consistent with the manufacturer's guidelines.

9.5.5.6 No Load Operation. Actual shop tests performed on a prototype KSV-20-T diesel engine showed the engine capable of running at no load for an extended period. Following 6 hours of no load operation at rated speed, the engines were subjected to a 75-percent-load test for 1 hour, followed by a 50-percent-load test for 1 hour. Based upon the prototype testing, no adjustments need to be made to the STPEGS engines or controls. The engine is capable of accepting full load after as much as 6 hours of low load or no load operation. The operating procedures require interspersing 15-30 minute periods of operation at 75-100 percent load at approximately 6-hour intervals when operating the diesel for longer than 6 hours at light loads (less than 50 percent). The above conditions for low-load operation of the DGs are applicable when the diesels are operated for any reason, including testing or troubleshooting.

9.5.6 Diesel Generator Starting System

9.5.6.1 Design Bases. Each DG is provided with two compressed starting air systems, either of which is capable of starting the engine without power. The starting air system, including the interconnecting piping, is designed to seismic Category I, SC 3 requirements, except the compressors and dryers, which are NNS. The on-engine piping (Table 9.5.4-1) is designed to DEMA requirements and meets ANSI B31.1 and ANSI N45.2. The DG has also been subjected to 10CFR50 Appendix B QA. The equipment is located within the DG compartments and is therefore protected from tornado winds, external missiles, flooding, and the effects of moderate-energy line breaks (Chapter 3).

9.5.6.2 System Description. A schematic of the redundant DG Starting Air System for one diesel engine is shown on Figure 9.5.6-1. Each Starting Air System includes two AC-motor-driven air compressors, two air dryers, two air receivers, two starting air valves, all necessary valves and fittings, instrumentation, and control systems. Table 9.5.6-l lists major components in the DG Starting System and their design data.

Each redundant air receiver is isolated from the nonsafety-related portions of the Starting Air System by one check valve and a manually operated isolation valve. Each receiver has a volume of 83 ft^3, a design pressure of 275 psig, and a maximum operating pressure of 250 psig. This is sufficient for five consecutive start attempts per receiver without recharging. In the emergency mode, the cranking limit timer is bypassed. If the engine starts, the starting air is shut off by a speed relay switch. If the diesel engine does not start, the air would be expended from both receivers in an attempt to start the engine. The receiver is constructed of stainless steel. The air compressors are sized to recharge each receiver from minimum pressure to maximum pressure in l7 minutes. Each receiver is provided with a pressure switch to start (240 psi) and stop (250 psi) the compressors as required. Low pressure is set at 175 psi, is alarmed locally, and has a common trouble alarm in the main CR. There is no high pressure alarm. High pressure safety relief valves are provided.

From the receiver, the air flows to the engine-mounted components through stainless steel interconnecting piping. The on-engine components consist of two strainers, four pilot-solenoid, air-operated starting valves, two rotary air distributors, and the air headers for the left and right cylinder banks. The on-engine piping is also stainless steel.

The Starting Air System also supplies instrument air for essential and nonessential engine controls and air for the air motor on the maintenance barring device.

Carryover of moisture, oil, and corrosion products to the starting air valves is prevented by filters at the compressor inlet and membrane dryers at the compressor discharge. Drains are also provided on the air receivers. The air dryers have a pre- and after-filter to prevent oil from saturating and contaminating the membrane dryer and carryover to the Starting Air System. In addition, other in-line filters are provided as indicated in Figure 9.5.6-1. Furthermore, stainless steel is used for all surfaces exposed to starting air.

Each air compressor serves one receiver tank. The compressors start when the air receiver pressure is 240 psig falling and stops when the pressure reaches 250 psig. The compressors are powered from a 480 V non-Class 1E MCC.

A check valve between the air dryer and air receiver ensures that a broken line will not result in a sudden loss of air. The pressure relief valve between the compressor and dryer is set at 275 psig and the relief valve on the receiver is set at 265 psig. The relief valves in the air receivers can be manually tripped for test or for blowing down the receiver pressure.

Compressed air from the starting air receivers is applied to the starting air control valves, which are controlled by the starting air solenoid valves. When the starting air control valves open, starting air is supplied to both banks of air start valves and air distributors. One start valve is located in each cylinder head and all are controlled by the air distributors.

9.5.6.3 System Evaluation. The starting system for each DG is completely independent of the starting systems of the two other DGs; consequently, failure of one starting system will result in failure of that DG only. The remaining DGs will be able to safely shut down the plant or mitigate the effects of a Loss-of-Coolant Accident (LOCA) coincident with a LOOP. An FMEA is provided in Table 9.5.5-2.

9.5.6.4 Inspection and Testing Requirements. Periodic tests are performed to ensure system operability. Inspection and scheduled maintenance will be performed periodically using the manufacturer's recommendations and procedures. Inservice inspection will be performed in accordance with the requirements of ASME B&PV Code, Section XI.

The Starting Air System will be periodically tested as a minimum during the regularly scheduled tests of the DGs. Testing can be performed without affecting normal plant operation.

9.5.6.5 Instrumentation. Controls and alarms are provided at the local panel for:

1. Independently starting and stopping the compressors

2. Opening each starting air valve

3. Alarming low starting air pressure with a common DG alarm in the main CR

Indication of starting air pressure upstream of the starting air valves is provided in the CR and locally.

The DG Starting Air System indications and alarms are summarized in Table 9.5.6-2. Instruments are checked during periodic testing of the engine. The initial calibration frequency for the control instruments associated with the diesel starting air system will be at least once every 18 months. Each starting system air dryer will be checked and maintained in accordance with the vendor's recommendation.

The operator action required following alarm actuation is specified in the annunciator response procedure. These actions are consistent with the manufacturer's guidelines.

These activities will be governed by plant procedures.

9.5.7 Diesel Generator Lubrication System

9.5.7.1 Design Bases. The DG Lubrication System is designed to provide a self-contained lube oil system for each DG engine. The system is safety-related and consequently is designed to seismic Category I, SC 3, up to the engine-mounted components. The engine-mounted components are designed in accordance with the DEMA requirements and meet ANSI B31.1, ANSI N45.2, seismic Category I requirements, and 10CFR50 Appendix B QA (Table 9.5.4-1).

The equipment is located within the DG compartments and therefore is protected from tornado winds, external missiles, flooding, and the effects of moderate-energy line breaks (Chapter 3).

9.5.7.2 System Description. The lubrication system of each engine includes a direct engine-driven lube oil pump, an AC-motor-driven lube oil standby pump, an AC-motor-driven circulation pump, lube oil filters and strainers, a lube oil cooler, a thermostatic valve, an electric lube oil heater, and all necessary valves, fittings, piping, and instrumentation. The standby pump and circulation pump motors are powered from 480 V Class 1E MCCs. A schematic of the DG Lubrication System is shown on Figure 9.5.7-1. Table 9.5.7-1 lists the major components in the lubrication system and their design data.

The engine-driven lube oil pump has sufficient capacity to ensure adequate lubrication of all wearing parts as required. The AC-motor-driven lube oil standby pump has sufficient capacity to replace the engine-driven pump should it fail. The lube oil pumps take oil from the lube oil sump through a strainer and deliver it to the thermostatic valve. This valve controls the lube oil temperature by bypassing a portion of the lube oil flow around the lube oil cooler. From the thermostatic valve and the lube oil cooler, the lube oil temperature by bypassing a portion of the lube oil flow around the lube oil cooler. From the thermostatic valve and the lube oil cooler, the lube oil flows first through a full-flow oil filter and then through a duplex lube oil strainer. The lube oil then flows to the various engine components requiring lubrication and/or oil cooling and returns to the engine lube oil sump.

Pressure relief valves are provided on the discharge of the oil pumps and on the engine supply header. A pressure regulator regulates oil pressure to the turbocharger. Oil flow is not monitored while oil pressure and temperature are monitored.

Protective functions (including interlocks) for the DGs are discussed in Section 8.3.1.1.4.6.

The oil filter may be manually bypassed for cleaning during operation. If necessary for plant protection, the filter can be manually bypassed for a short duration.

The system also includes a prelubricating and preheating system to keep the engine ready for quick starts. It consists of an AC-motor-driven circulation pump, which takes suction from the engine lube oil sumps, and an electric heater which comes on when lube oil temperature is 120°F falling and turns off at 130°F rising, heating the lube oil to operating temperature. From the heater, the lube oil flows through the main oil filter and then to the various engine components requiring lubrication. The circulation pump starts when the engine rpm falls below 280. A control interlock with the standby lube oil pump prevents simultaneous operation of the standby and circulating lube oil pumps due to improper start signals. Therefore, potential damage to the circulating lube oil pump and/or the standby lube oil heater is prevented.

Essential cooling water at a flow rate of 300 gal/min is the source of cooling water for the lube oil coolers. Normal inlet temperature for this water is 95°F while the normal outlet temperature is ll5°F. Maximum inlet temperature is 106°F while the maximum outlet temperature is l26°F. Heat removal rate is approximately 2,960,000 Btu/hr for the above conditions which is technically compatible with the engine manufacturer recommendations.

The engine is equipped with two pairs of low oil pressure shutdown switches to stop the engine in case oil pressure drops to 30 psig. One pair of these switches is located in the main header and the other is located downstream of the turbocharger pressure regulator. System leakage is routed to floor drains which are piped to individual sumps which are then pumped to the oily waste system for processing.

A sample of the lube oil is taken prior to the initial fill for analysis. Subsequent samples are obtained from the prefilter drain or instrument bleeding connections. If the sample fails to meet specifications, the lube oil is drained through the permanent connections from the auxiliary skid routed outside the DGB to a truck via a fill station. A fill connection is also provided at this station, and an in-line strainer is provided on the fill line inside the DGB. The initial frequency for sampling the diesel lube oil will be at least monthly. This frequency may be revised based upon evaluations of factors such as plant operating experience, industry experience, and vendor recommendations. This sampling will be governed by plant procedures which will be in place prior to fuel load. The appropriate plant personnel will be trained in their use.

9.5.7.3 System Evaluation. The Lube Oil System for each DG is completely independent of the lube oil systems of the other DGs. Therefore, failure of one lube oil system will result in loss of only one DG. The remaining DGs will be adequate to safely shut down the plant or mitigate the effects of a LOCA during LOOP conditions. An FMEA is provided in Table 9.5.5-2.

9.5.7.4 Inspection and Testing Requirements. The DG Lubrication System will be inspected and tested during the regularly scheduled tests of the DGs. Inservice inspection shall be performed in accordance with the ASME B&PV Code, Section XI.

9.5.7.5 Instrumentation. A common trouble alarm will be provided in the main CR and individual alarms in the local panel for low oil pressure, high and low oil temperature, high and low lube oil level, high filter and high strainer differential pressures. Indication is provided in the main CR and locally for oil pressure and oil temperature. Indication is also provided locally for lube oil level in the crank case. The Lube Oil System indications and alarms are summarized in Table 9.5.7-2.

The initial calibration frequency for the instruments associated with the diesel lubrication system will be at least once every 18 months. This frequency may be revised based upon evaluations of factors such as plant operating experience, industry experience, and vendor recommendations.

The operator action required following alarm actuation is specified in the annunciator response procedure. These actions are consistent with the manufacturer's guidelines. Alarms are verified operable as described in Section 13.5.2.

The DG protective trips are discussed in Section 8.3.

9.5.8 Diesel Generator Combustion Air Intake and Exhaust System

9.5.8.1 Design Bases. The Diesel Generator Combustion Air Intake and Exhaust System (DGCAIES) is designed to supply the DG engine with a sufficient quantity of combustion air to enable it to perform its safety function and to then discharge the exhaust gases so that the gases do not dilute the combustion air sufficiently to affect the operation of the DG engine. The on-engine piping and components are design to DEMA requirements and meet ANSI B31.1, ANSI N45.2, and 10CFR50 Appendix B QA.

The following components are designed in accordance with manufacturer's standards:

1. Expansion joints
2. Oil-bath air intake filter and silencer
3. Exhaust silencers
4. Air heaters/air coolers
5. Turbochargers
6. Valve for overspeed shutdown

All components are designed to seismic Category I requirements. In addition, each DG and its associated Combustion Air Intake and Exhaust System is located in a physically separated, tornado-, flood-, and missile-proof structure, and is protected from the effects of moderate line breaks (Chapter 3).

9.5.8.2 System Description. A schematic of the DGCAIES is shown on Figure 9.5.8-1. The relative location of system equipment in the facility is shown on Figure 1.2-l0.

Each DGCAIES consists of:

1. Combustion air intake filter and silencer (oil-bath type)
2. Exhaust silencer
3. Combustion air manifold
4. Exhaust manifold
5. Turbocharger
6. Air heaters/air coolers (one each per cylinder bank)
7. Connecting piping and expansion joints
8. Overspeed shutdown valve

The DGs are designed to deliver rated load at an ambient air intake temperature of 29-95°F (81°F wet bulb) and at a pressure depression of 3 psi in 1.5 seconds, followed by a rise to normal pressure in 1.5 seconds.

Outside air for combustion is drawn into the building through a separate missile-protected opening above the maximum flood level. Intake air velocity is limited to prevent the entry of rain or snow, thus eliminating the possibility of clogging the air intake or otherwise degrading performance. All portions of the DGCAIES, except the air intake opening and the end of the exhaust pipe, are located within the DGB.

Air is drawn in through the combustion air intake filter and silencer and flows through the connecting piping and expansion joints to the overspeed shutdown valve and into the compressor stage of the turbocharger. From the turbocharger, the air flows through the air heaters/intercoolers and into the combustion air manifolds, where it becomes available to the power cylinders on demand.

The exhaust gases are released into the exhaust manifold and into the turbine of the turbocharger. The exhaust gases expand through the turbocharger turbine and flow through the interconnecting piping and expansion joints to the exhaust silencer. From the silencer, the exhaust gases are routed out of the DGB, via a horizontal pipe approximately 65 ft above grade (Figure 1.2-10). A hood attached to the building extends partially around the exhaust pipe to prevent entry of rain, snow, and freezing rain into the exhaust. It should be noted that ice, snow, and freezing rain are considered insignificant since STPEGS is located in a subtropical maritime climate (Sections 2.3.1.2.3 and 2.3.1.2.4). The effects of dust accumulation on the exhaust is not considered significant based upon the height of the exhaust above the ground (approximately 65 ft) and the layout of the facilities in the area of the exhaust. The discharge is also provided with a bird screen.

The exhaust hood which extends approximately 2 ft from the building is designed as a break-off section. In the unlikely event a missile strikes the exhaust hood, the break-off section will separate from the building thereby not inhibiting engine exhaust performance. The exhaust piping extends only 3 in. beyond the wall thus providing minimal exposure to tornado missiles.

The overspeed shutdown valve located in the turbocharger is controlled by the engine overspeed protection device. Upon a signal from the overspeed protection device, the overspeed shutdown valve closes, shutting off the combustion air supply to the engine, thus providing a positive shutdown.

9.5.8.3 Safety Evaluation. The Combustion Air Intake and Exhaust System for each DG is completely independent of the Intake and Exhaust System of the other two DGs. Consequently, failure of one Intake and Exhaust System will result in the failure of only that DG. The remaining DGs will be able to safely shut down the plant or mitigate the effects of an LOCA in the event of a coincident LOOP.

Air from outside the DGB is drawn through fixed louvers and the intake air filter. These louvers are surrounded by a missile wall barrier such that an external missile cannot penetrate and cause damage to any of the DG components. The louvers are located above the design flood level.

Liquid nitrogen, carbon dioxide, and gaseous hydrogen are stored in outdoor tanks at the STPEGS site in the Bulk Gas Storage Facility. An analysis has been performed which shows that, in the unlikely event of an instantaneous rupture of any of these tanks, the resulting gas concentrations at the DG air intake would not adversely affect DG operation. Under these conditions, the engine is still capable of carrying its rated load. The following assumptions were used in the analysis:

1. Distance from the tanks to the DG air intake, 486 ft

2. 11,000 gallons of liquified nitrogen, 50,000 standard cubic feet (scf) liquid carbon dioxide, 200,000 scf hydrogen

3. Plume dispersion equations using the methodology in NUREG-0570

4. Pasquill Type F meteorology

5. Air intake 65 ft above grade

6. Briggs plume rise equations for lighter-than-air gases

7. The DGs will operate at an oxygen deficiency of up to 20 percent which is equivalent to an oxygen concentration of 16.7 percent

The results indicate that the nitrogen and hydrogen concentrations at the DG intake will be negligible, due to the buoyancy of the plumes. The carbon dioxide concentration is found to be limiting and will result in approximately 19.3 percent reduction of the oxygen concentration at the DG intake which is equivalent to an oxygen concentration of 16.9 percent.

The following is an assessment of the influence of diesel exhaust gases and smoke from fires in nearby buildings which could affect the operation of the DGs:

1. As shown in Figure 1.2-l0 the diesel exhaust is discharged to the atmosphere through the north wall of the DGB. A southerly wind would cause the DG exhaust to be captured in the auxiliary building wake cavity, but the DG exhaust would undergo a 55 fold dilution within this wake cavity and would not adversely impact DG operation.

   It should be noted credit was not taken in these evaluations for the buoyancy of the hot DG exhaust. Smoke from fires in buildings surrounding the DGB are bounded by the MAB exhaust which undergoes at least a 10.5 fold dilution in the building wake cavity and, therefore, will not adversely affect DG operation (i.e., the threshold of dilution is 5). The only gaseous fire extinguishing medium for STPEGS is Halon (Para: 9.5.1.2.19.11) used in the relay room, the computer room, the TSC computer room in the EAB. Release of Halon from these areas would be a controlled operation. No fire extinguishing gaseous medium is used for fire protection for the DGB.

2. From a geometrical standpoint, the combustion air intake louvers on the north side of the DGB are 90 degrees with respect to the auxiliary ESF transformers which are approximately 20 ft east and l0 ft south of the building. The transformers are supplied with an automatic deluge system. A class B fire could result from an oil spill or internal shorts. Thirty-minute response time and 30-minute fire brigade action would result in extinguishing the fire via existing fire hydrants or fire department connections with access to the deluge valve immediately adjacent to the DGB, in case of a single failure of the automatic deluge system.

An analysis using the methods of James Halitsky in "Gas Diffusion Near Buildings" was performed (Ref. 9.5.8-1). The results indicate that the following reduction would occur in the oxygen level of the combustion air intake.

ESF Transformer or Auxiliary Fuel Oil Filtration Skid Fire - During the period from the start of the fire until the time it is extinguished, smoke could potentially be carried around to the north side of the DGB. The distance from the nearest ESF transformer to the closest air intake is about 30 ft. The distance from the nearest Auxiliary Fuel Oil Filtration Skid to the close out air intake is about 45 ft. By the Halitsky method the maximum oxygen deficiency caused by a single ESF transformer or auxiliary fuel oil filtration skid fire is 19.1 percent which is equivalent to an Oxygen concentration of 17.0 percent.

3. A single failure of the Fire Protection System could result in the unavailability of the sprinkler system for a given engine compartment or FOST room. The compartment ventilation system continues to be operational ensuring a purge of the smoke from the affected compartments. The smoke is exhausted approximately 30 ft south and 43 ft above the elevation of the combustion air intake louvers for all DG compartments except the FOST rooms. (Aspects of fire fighting are identical to those identified in item 2 above.) Until the closure of the thermal link dampers, the smoke will also be vented from the FOST on the north side of the DGB via the oil room exhaust fan and duct. The exhaust will be bounding for the effects of compartment fires inside the DGB.

   Smoke exhausted from this outlet would be diluted by a factor of 7.8 in the building wake cavity and, therefore, will not affect DG operation. Furthermore, the fire dampers will close within a few seconds, so these conditions will exist for only a limited period of time.

9.5.8.4 Inspection and Testing Requirements. The DGCAIES will be inspected and tested during the regularly scheduled tests of the DGs. The instrumentation provided to monitor the combustion air and exhaust temperature receives periodic calibration and inspection to verify accuracy.

9.5.8.5 Instrumentation. Alarms will be provided in the main CR and the local panel for intake air filter high differential pressure and for a failed turbocharger bearing. Indication is provided at the local control panel for intake air manifold temperature, turbocharger inlet and outlet air temperature, individual cylinder exhaust temperature, and intake air manifold pressure.

The initial calibration frequency for the instruments associated with the combustion air intake and exhaust system will be at least once every 18 months. This frequency may be revised based on evaluations of factors such as plant operating experience, industry experience, and vendor recommendations.

The operator action required following alarm actuation is specified in the annunciator response procedure. These actions are consistent with the manufacturer's guidelines.

9.5.9 Auxiliary Steam System

9.5.9.1 Design Bases. The Auxiliary Steam (AS) System is designed to operate independently from the main turbine thermal cycle steam systems. The system is shown on Figures 9.5.9-1 through 9.5.9-4. The AS system includes a boiler, with a design capacity of 145,000 lbs/hr of steam at 235 psig.

The AS System is designed to provide the steam requirements for both STPEGS units during various station operating modes. The AS System provides startup and pegging steam for the turbine plant deaerator, startup steam for the main turbine and steam generator feed pump turbine seals when no other steam source is available, and steam required for operation of evaporators on the LWPS and Boron Recycle System (BRS), as discussed in Section l1.2 and Section 9.3.4.2, respectively.

During normal operation, steam is provided to the AS System from the main steam header, either from Unit 1 or Unit 2. If a unit is shut down while the other unit is operating, steam supply to the AS System in the shutdown unit is normally from the operating unit. The AS System does not supply steam to safety-related equipment.

9.5.9.2 Deleted

9.5.9.3 System Safety Evaluation. The AS System is NNS and nonseismic. Loss of the functional capability of the AS System will not preclude safe shutdown of the Nuclear Steam Supply System. However, part of the AS System is provided with Class 1E room temperature sensors and two Class 1E high pressure differential switches across a flow element in the AS line. ASME Section III, Class 3 valves and a seismic Category I portion of Section III piping are also provided. The temperature sensors and high pressure differential switches are used to detect auxiliary steam line breaks in the MAB, and transmit signals to the safety class valves for isolation. This equipment is provided to limit the magnitude and duration of the harsh temperature environment in areas of the MAB which contain safety-related equipment due to AS System line breaks.

9.5.9.4 Deleted

9.5.9.5 Deleted

9.5.10 Auxiliary Fuel Oil Storage and Transfer System

9.5.10.1 Design Bases. The Auxiliary Fuel Oil Storage and Transfer System is designed to supply fuel oil to the following:

1. Standby DG Storage Tanks via the Auxiliary Fuel Oil Filtration Skids

2. AB Burner Pumps

3. Non-Class 1E Emergency DG Day Tanks

4. Fire Pump Diesel Driver FOST

5. Lighting System DG Day Tank

9.5.10.1.1 Performance Requirements: The Auxiliary Fuel Oil Storage and Transfer System stores adequate fuel oil for operating both ABs for 2l days. The transfer pumps, in conjunction with the Auxiliary Fuel Oil Filtration Skid pump, are capable of filling one standby DG storage tank in 8 hours. These capacities are more than adequate to fill other system fuel oil needs.

9.5.10.1.2 Code Design Requirements: The Auxiliary Fuel Oil Storage and Transfer System is a NNS Class system and therefore is not designed to seismic Category I requirements. The piping is designed in accordance with ANSI B31.1. The AFOST is designed in accordance with API 650 and API 2000.

9.5.10.1.3 Environmental Design Bases: The system conforms to the requirements of Environmental Protection Agency Guidelines Title 33.

9.5.10.2 System Description. Figure 9.5.l0-l shows the Auxiliary Fuel Oil Storage and Transfer System. The system is common to both Units l and 2.

The system consists of one storage tank, two transfer pumps, one fill pump, one truck fill connection oil sump and strainers, valves, piping, and instrumentation required in order to supply fuel oil to various plant systems and components.

The system is designed to fill a single standby DGFOST in 8 hours and to fill all three fire pump diesel oil storage tanks in 2 hours.

9.5.10.3 Safety Evaluation. The Auxiliary Fuel Oil Storage and Transfer System is not required for operation of safety-related equipment.

The connections to all DGFOST and fire pump diesel driver FOSTS are provided to make up fuel used during testing of their engines and following operation. The AFOST is a 240,000-gallon, floating, roof-type tank. It is located inside a dike designed to contain the full volume of fuel in the event of a tank rupture. Fire protection provisions for the tank are described in Section 9.5.1.

The AFOST will be physically separated from other Unit l structures as follows.

Structure	Distance (Approximate)
Reactor Containment Building	600ft
Mechanical Auxiliary Building	300 ft
Diesel Generator Building	600 ft
Electrical Auxiliary Building	500 ft
Fuel Handling Building	500 ft
Nearest CR air intake	600 ft

Distances to Unit 2 structures exceed those indicated above.

Makeup to the FOST is supplied by a truck via a fill pump.

9.5.10.4 Test and Inspections. The Auxiliary Fuel Oil Storage and Transfer System will be initially tested to ensure operability.

9.5.10.5 Instrumentation Application. Local controls are provided for the transfer and fill pumps to manually operate the system during testing, startup, and fill operations. Remote control is provided at the AB panel for operating the transfer pumps in the manual or automatic mode.

Instrumentation is shown on Figure 9.5.10-1. Local instrumentation is provided to monitor system parameters such as pressure, level, flow, and differential pressure. Selected remote instrumentation and alarms are provided at the AB panel.

REFERENCES

Section 9.5

9.5.8-1 Halitsky, J., "Gas Diffusion Near Buildup", ASHRAE Transcript, 69:464-484 (1963).

TABLE 9.5-1

FIRE PROTECTION SYSTEM
FAILURE MODES AND EFFECTS ANALYSIS

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Safety Function Capability	General Remarks
Fire Water Storage Tanks (typical)	None provides water for fire protection service	1-6	Tank rupture, leakage	Low water level alarm in control room	None - 100% redundant storage tank available	
			Insufficient water supply	Low water level alarm in control room	None - 100% redundant storage tank available	
Fire Pump (FP) Gate Valve, Normally Open (typical)	None, provides isolation of line	1-6	Gate valve closed	Audible and visual alarm provided in control room	None - 100% redundancy with other lines	
FP Gate Valve, Normally Open (typical)	None, provides isolation of fire pump or line segment	1-6	Gate valve closed	Audible and visual alarm provided in control room	None - 100% redundancy provided by 2-100% pumps. Alternate routing of water	
FP Gate Valve Locked Open FP0580 or FP0581	None, provides isolation in the event of line rupture of supply header on tank	1-6	Gate valve closed	Periodic visual inspection	None - Worst case condition 2-100% pumps will receive 100% water supply from the other tank	

* Plant Modes

1. Power Operation
2. Startup
3. Hot Standby
4. Hot Shutdown
5. Cold Shutdown
6. Refueling

TABLE 9.5-1 (Continued)

FIRE PROTECTION SYSTEM
FAILURE MODES AND EFFECTS ANALYSIS

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Safety Function Capability	General Remarks
Fire Pump (typical)	None, operate and deliver water to system in the event of fire	1-6	Fails	Audible and visual alarm – local and control room	None - Two 100% pumps remaining available will provide required supply of water	
			Shutdown due to engine overspeed	Audible and visual alarm – local and control room	None - Two 100% pumps remaining available will provide required supply of water	
			Insufficient water pressure	Second pump actuation	None - Two 100% pumps remaining available will provide required supply of water	
			Loss of AC power	Audible and visual alarm	None - All pumps will start upon loss of AC power since dual starting batteries are provided for each pump. Only one (1)-100% pump is necessary to meet system requirements for Category I Buildings	
FP Check Valve (typical)	None, prevents one tank from draining if rupture of leak in other tank	1-6	Valve fails to close	Periodic visual inspection – low level alarm on tank	None - Tank can be isolated, water is then supplied by redundant line	

* Plant Modes

1.	Power Operation	4.	Hot Shutdown
2.	Startup	5.	Cold Shutdown
3.	Hot Standby	6.	Refueling

TABLE 9.5-1 (Continued)

FIRE PROTECTION SYSTEM
FAILURE MODES AND EFFECTS ANALYSIS

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Safety Function Capability	General Remarks
FP Check Valve FP0019, 0025, or 0048	None, open to allow flow	1-6	Fails to open	None	None - Adequate flow is provided through (or via) the two remaining lines	
Check Valve FP0943	Containment isolation	1-6	Leaks	Visual inspection	None - MOV FP0756 is available	
MOV FP0756 (normally closed)	Containment isolation	1-6	Fails to close	Visual indication on main control panel, ESF status monitoring	None - Check Valve FP0943 is available	
			Fails to open	Indicator lights	None - Redundant backup available with portable extinguishers	
Pneumatic Diaphragm Butterfly Valve (solenoid actuated) (typical)	None, regulates flow into tanks	1-6	Solenoid fails to operate butterfly valve	Low water level alarm locally and in control room	None - 100% redundancy with other tank	
			Valve fails to close	High water level alarm locally and in control room	None - 100% redundancy with other tank also 14 in. overflow pipe available in event of overflow	

* Plant Modes

1. Power Operation
2. Startup
3. Hot Standby
4. Hot Shutdown
5. Cold Shutdown
6. Refueling

TABLE 9.5-1 (Continued)

FIRE PROTECTION SYSTEM
FAILURE MODES AND EFFECTS ANALYSIS

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Safety Function Capability	General Remarks
Line Segment out of service, any	None, water supply for fire protection	1-6	Loss of water to segment	Low system pressure, actuation of pumps alarm in control room	None - Redundancy, and/or hand-held extinguishers, and.or foam/Halon depending upon where line segment is out of service	
Protection Sprinkler System, DGB	None, fire protection of diesel generator	1-6	Loss of supervisory air	Visual and audible alarm in control room	None - System is not charged until actuation of deluge valve. Backup protection provided by standpipe after system is isolated	
Halon Cylinder Isolation Valve Diaphragm Valve (normally closed)	None, actuation of valve releases Halon into designated area	1-6	Fails to open	Visual inspection	None - Redundant cylinder bank available or manual actuation	
Halon Cylinder Check Valve	None, actuation releases Halon into designated area	1-6	Fails to open	Visual inspection	None - Redundant cylinder bank available or manual actuation	

* Plant Modes

1. Power Operation
2. Startup
3. Hot Standby
4. Hot Shutdown
5. Cold Shutdown
6. Refueling

TABLE 9.5-1 (Continued)

FIRE PROTECTION SYSTEM
FAILURE MODES AND EFFECTS ANALYSIS

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Safety Function Capability	General Remarks
System Isolation Valves 1008 or 1010	None, actuation releases Halon into the designated area	1-6	Fails to open	Upon actuation of second detector there is no high pressure alarm signifying Halon flow	None - Manual actuation or backup protection provided by standpipe or handheld extinguisher	
Class 1E AC Power Train C	Provide power to Train C AC components	1-6	Loss of power on bus	Bus undervoltage alarms	None - Check valve FP0943 in series with Train C isolation valve MOV-FP0756 will perform isolation function if required	
				ESF Status monitoring for ESF diesel generator system and components		
				ESF monitoring for system and AC components		
ESF Actuation System Train C	Provide actuation signals as required to safety related components	1-6	Fails to generate and send actuation signals	Loss of power or actuation train in test is alarmed by ESF status monitoring	None - Check valve FP0943 in series with Train C isolation valve MOV-FP0756 will perform isolation function if required	Manual actuation is possible to close

* Plant Modes

1.	Power Operation	4.	Hot Shutdown
2.	Startup	5.	Cold Shutdown
3.	Hot Standby	6.	Refueling

TABLE 9.5-1 (Continued)

FIRE PROTECTION SYSTEM
FAILURE MODES AND EFFECTS ANALYSIS

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Safety Function Capability	General Remarks
ESF Actuation System Train C (continued)				Individual bistables used to generate actuation signals are individually provided with lights and computer inputs and, combined with other similar inputs (for same signal), are alarmed on annunciator, all on main control board		

* Plant Modes

1.	Power Operation	4.	Hot Shutdown
2.	Startup	5.	Cold Shutdown
3.	Hot Standby	6.	Refueling

TABLE 9.5-2

CODES, STANDARDS, AND REGULATIONS

Issued by	Number	Title
ANSI	B31.1	Power Piping Code
ANSI	N18.10	Fire Protection Criteria for Safety-related Systems, Structures, and Equipment for Water-cooled and Moderated Nuclear Power Generating Plants
ANSI	N45.2.1	Cleaning of Fluid Systems and Associated Components for Nuclear Power Plants
ASME B&PV Code	Section III	Nuclear Power Plant Components
ASME B&PV Code	Section IX	Welding Qualifications
FM		Factory Mutual Approval Guide
IEEE	384	Standard Criteria for Separation of Class 1E Equipment and Circuits
NFPA	72E	Automatic Fire Detectors
NFPA	20	Centrifugal Fire Pumps
NFPA	16	Deluge Foam-Water Sprinkler Systems and Foam Water Spray Systems
NFPA	196	Fire Hose
NFPA	30	Flammable and Combustible Liquids Code
NFPA	11	Foam Extinguishing Systems
NFPA	50A	Gaseous Hydrogen Systems
NFPA	12A	Halon 1301 Extinguishing Systems
NFPA	49	Hazardous Chemical Data
NFPA	37	Installation and Use of Stationary Combustion Engines and Gas Turbines
NFPA	78	Lightning Protection

TABLE 9.5-2 (Continued)

CODES, STANDARDS, AND REGULATIONS

Issued by	Number	Title
NFPA	70	National Electric Code
NFPA	10	Portable Fire Extinguishers
NFPA	27	Private Fire Brigades
NFPA	24	Private Fire Service Mains and Their Appurtenances
NFPA	72D	Proprietary Protective Signaling Systems
NFPA	232	Protection of Records
NFPA	231C	Rack Storage of Materials
NFPA	803	Recommended Fire Protection Practice for Nuclear Reactors
NFPA	194	Screw Threads and Gaskets for Fire Hose Connections
NFPA	13	Sprinkler Systems
NFPA	14	Standpipe and Hose Systems
NFPA	15	Water Spray Fixed Systems
NFPA	22	Water Tanks
OSHA	Ch. XVII Title 29	Occupational Safety and Health Act
UL		Underwriters' Laboratories Fire Protection Equipment List

TABLE 9.5.2-1

COMMUNICATION EQUIPMENT
AVAILABLE FOR SAFE SHUTDOWN

Location	Available Equipment[5]
Auxiliary Shutdown Panel	A, B, C, D, E
Transfer Switch Panels	A, B, C (Notes 1 and 4)
Standby Diesel Generator Control Panel	A, B, C, D (Note 4)
Chiller Control Panels	A, B, C, D (Notes 2 and 4)
Boric Acid Tank Room	C, D
CCW Surge Tank Room	A, B, C, D (Note 4)
ECW Traveling Screen Rooms	A, B, C, D (Note 4)
Auxiliary Feedwater Storage Tank Area	A, B, D (Notes 3 and 4)

1. Two-way radio not to be used in the switchgear rooms.
2. Train A chiller control panel does not have convenient access to maintenance jacks.
3. Distance to nearest telephone is approximately 80 ft, located in the cold chemical laboratory.
4. The Public Address System can only be heard in these locations.
5. Legend:
   A – Telephone
   B – Public Address
   C – Maintenance Jack
   D – Lossy Loop 2-Way Radio
   E – Operator Communications Panel

TABLE 9.5-3

FIRE PROTECTION SYSTEMS

Type	Area Protected
Wet-pipe Sprinklers (Automatic)	Turbine Generator Building (TGB), Fire Pump House, Contractor's Work Facility, certain areas of the Mechanical-Electrical Auxiliaries Building (MEAB), including concentrated cable areas, and sprinkler systems located at the ceiling for each cable spreading room and power cable vault.
Preaction Sprinklers (Automatic)	Diesel Generator Building (DGB) engine rooms, and the Lighting Diesel Generator Building.
Preaction Sprinklers (Manual)	Turbine generator bearings Switchgear Rooms, Trains A, B & C (EAB)
Water Spray Deluge (Automatic)	Main, auxiliary, and standby transformers, auxiliary Engineered Safety Features (ESF) transformers, balance-of-plant transformers, TGB cable tray vault, lube oil reservoir, lube oil storage and conditioner, hydrogen seal oil unit, steam generator feed pump turbine lube oil system.
Water Spray Deluge (Manual)	HVAC Carbon Filters, Reactor Containment Building (RCB) Train B cable trays.
Standpipe and Hoses (Wet)	TGB, Fuel-Handling Building, MEAB, Isolation Valve Cubicle, DGB, Lighting Diesel Generator Building.
Standpipe and Hoses (Manual Preaction)	RCB
Foam Extinguishing	Auxiliary Fuel Oil Storage Tank
Foam-Water Sprinkler	DGB Fuel Oil Storage Tanks
Yard Main and Hydrants	External coverage of all plant buildings and area, intake structures, and auxiliary boiler

TABLE 9.5-3 (Continued)

FIRE PROTECTION SYSTEMS

Type	Area Protected
Halon 1301	Relay cabinet area of the control room, plant computer room, battery and electrical distribution rooms, Technical Support Center Computer Room
Portable Extinguishers	Plant buildings and structures

TABLE 9.5.3-1

LIGHTING AT SAFE SHUTDOWN AND ACCESS/EGRESS AREAS

Areas	Essential AC Lighting Backed By Class 1E DG	Essential AC Lighting Backed By Non-Class 1E DG	8 Hr Emergency DC Lighting	Normal AC Lighting
1. Control Room	Yes	N/A	Yes	N/A
2. Auxiliary Shutdown Panel	Yes	N/A	Yes	N/A
3. Transfer Switch Panels	Yes	N/A	Yes	N/A
4. Access/Egress Between 1, 2, and 3 above	Yes	N/A	Yes	Yes
5. Standby Diesel Generator Control Panels	N/A	Yes	Yes	Yes
6. Chiller Control Panels	N/A	Yes	Yes	Yes
7. Boric Acid Tank Room and Component Cooling Water Surge Tank	N/A	Yes	Yes	Yes
8. Access/Egress between 5, 6 above	N/A	Yes	Yes	Yes

TABLE 9.5.4-1

DIESEL ENGINE MANUFACTURER'S STANDARDS

Outside Dia. (inches)	Material Specification	Wall Thk. (inches)	Wall Thk. Req'd[(1)] For Sys. Press. (in.)	ANSI B.31.1/ASME III[(2)] Allowable Press. (psi)	System Working Press. (psi)
AIR STARTING SYSTEM					
3.500	A-312 GR-TP316 Pipe	0.083	0.023	908	250
2.375	A-312 GR-TP316 Pipe	0.065	0.016	1052	250
1.315	A-312 GR-TP316 Pipe	0.065	0.009	1932	250
1.050	A-312 GR-TP316 Pipe	0.065	0.007	2448	250
0.50	A-312 GR-TP316 Tube	0.035	0.003	2788	250
0.313	A-312 GR-TP316 Tube	0.035	0.002	4617	250
0.25	A-312 GR-TP316 Tube	0.035	0.002	5927	250
0.325	A-312 GR-TP316 Tube	0.035	0.002	4430	250
10.750	A-106 GR-B	0.365	0.084[(3)]	1047	60

1. Wall thickness required to restrain system pressure calculated using equations and procedures from ANSI B31.1-1983 and ASME Codes. Most conservative fabrication and material properties were assumed.
2. Maximum system pressures allowed for as delivered pipe using method and equations from ANSI B31.1 and ASME Codes. Most conservative fabrication and material properties were assumed.
3. Included corrosion allowance (1/16 in.) for carbon steel pipes for water and air systems.

TABLE 9.5.4-1 (Continued)

DIESEL ENGINE MANUFACTURER'S STANDARDS

Outside Dia. (inches)	Material Specification	Wall Thk. (inches)	Wall Thk. Req'd[1] For Sys. Press. (in.)	ANSI B.31.1/ASME III[2] Allowable Press. (psi)	System Working Press. (psi)
AIR STARTING SYSTEM (Cont'd)					
6.625	A-106 GR-B	0.280	0.076[3]	1312	60
3.500	A-106 GR-B	0.216	0.07[3]	1947	60
2.375	A-106 GR-B	0.154	0.068[3]	2051	60
FUEL OIL SYSTEM					
1.660	A-106 GR-B	0.140	0.002	2713	35
1.315	A-106 GR-B	0.133	0.002	3306	35
1.050	A-106 GR-B	0.113	0.001	3532	35
0.840	A-106 GR-B	0.109	0.001	4343	35
1.250	A-312 GR-TP316	0.083	0.001	2636	35
1.00	A-312 GR-TP316	0.049	0.001	1917	35
0.75	A-312 GR-TP316	0.049	0.001	2592	35
0.50	A-312 GR-TP316	0.035	0.001	2788	35

1. Wall thickness required to restrain system pressure calculated using equations and procedures from ANSI B31.1-1983 and ASME Codes. Most conservative fabrication and material properties were assumed.
2. Maximum system pressures allowed for as delivered pipe using method and equations from ANSI B31.1 and ASME Codes. Most conservative fabrication and material properties were assumed.
3. Included corrosion allowance (1/16 in.) for carbon steel pipes for water and air systems.

TABLE 9.5.4-1 (Continued)

DIESEL ENGINE MANUFACTURER'S STANDARDS

Outside Dia. (inches)	Material Specification	Wall Thk. (inches)	Wall Thk. Req'd[1] For Sys. Press. (in.)	ANSI B.31.1/ASME III[2] Allowable Press. (psi)	System Working Press. (psi)
FUEL OIL SYSTEM (Cont'd)					
0.375	A-312 GR-TP316	0.035	0.0003	3792	35
1.315	A-106 GR-B	0.133	0.004	3306	100
1.050	A-106 GR-B	0.113	0.004	3532	100
0.840	A-106 GR-B	0.109	0.003	4343	100
LUBE OIL SYSTEM					
8.625	A-106 GR-B	0.322	0.029	1446	100
6.625	A-106 GR-B	0.280	0.022	1312	100
3.500	A-106 GR-B	0.216	0.012	1947	100
2.375	A-106 GR-B	0.154	0.008	2051	100
1.900	A-106 GR-B	0.145	0.006	2438	100
1.660	A-106 GR-B	0.140	0.006	2713	100
1.315	A-106 GR-B	0.133	0.004	3306	100

1. Wall thickness required to restrain system pressure calculated using equations and procedures from ANSI B31.1-1983 and ASME Codes. Most conservative fabrication and material properties were assumed.
2. Maximum system pressures allowed for as delivered pipe using method and equations from ANSI B31.1 and ASME Codes. Most conservative fabrication and material properties were assumed.
3. Included corrosion allowance (1/16 in.) for carbon steel pipes for water and air systems.

TABLE 9.5.4-1 (Continued)

DIESEL ENGINE MANUFACTURER'S STANDARDS

Outside Dia. (inches)	Material Specification	Wall Thk. (inches)	Wall Thk. Req'd[1] For Sys. Press. (in.)	ANSI B.31.1/ASME III[2] Allowable Press. (psi)	System Working Press. (psi)
LUBE OIL SYSTEM (Cont'd)					
1.500	A-269 GR-TP304	0.065	0.005	1454	100
1.250	A-269 GR-TP304	0.083	0.004	2272	100
1.000	A-269 GR-TP304	0.049	0.003	1652	100
0.750	A-269 GR-TP304	0.049	0.002	2233	100
0.375	A-269 GR-TP304	0.035	0.001	3368	100
0.250	A-269 GR-TP304	0.035	0.001	5108	100
INJECTION COOLING SYSTEM					
6.625	A-106 GR-B	0.280	0.074[3]	1312	50
4.500	A-106 GR-B	0.237	0.07[3]	1634	50
1.900	A-106 GR-B	0.145	0.066[3]	2438	50
1.000	A-269 GR-TP304	0.049	0.002	1652	50
0.500	A-269 GR-TP304	0.035	0.001	2402	50

1. Wall thickness required to restrain system pressure calculated using equations and procedures from ANSI B31.1-1983 and ASME Codes. Most conservative fabrication and material properties were assumed.
2. Maximum system pressures allowed for as delivered pipe using method and equations from ANSI B31.1 and ASME Codes. Most conservative fabrication and material properties were assumed.
3. Included corrosion allowance (1/16 in.) for carbon steel pipes for water and air systems.

TABLE 9.5.4-1 (Continued)

DIESEL ENGINE MANUFACTURER'S STANDARDS

Outside Dia. (inches)	Material Specification	Wall Thk. (inches)	Wall Thk. Req'd[1] For Sys. Press. (in.)	ANSI B.31.1/ASME III[2] Allowable Press. (psi)	System Working Press. (psi)
INJECTION COOLING SYSTEM (Cont'd)					
0.375	A-269 GR-TP304	0.035	0.001	3268	50
0.250	A-269 GR-TP304	0.035	0.0004	5108	50
TURBOCHARGE WATER SYSTEM					
2.375	A-106 GR-B	0.154	0.067[3]	2051	60
3.500	A-106 GR-B	0.216	0.07[3]	1947	60

1. Wall thickness required to restrain system pressure calculated using equations and procedures from ANSI B31.1-1983 and ASME Codes. Most conservative fabrication and material properties were assumed.
2. Maximum system pressures allowed for as delivered pipe using method and equations from ANSI B31.1 and ASME Codes. Most conservative fabrication and material properties were assumed.
3. Included corrosion allowance (1/16 in.) for carbon steel pipes for water and air systems.

TABLE 9.5.5-1

DIESEL GENERATOR COOLING WATER
SYSTEM DESIGN DATA

Equipment	Quantity Per Unit	Capacity
Jacket Water Cooler	3 (1 per diesel)	6,240,000 to 8,030,000 Btu/hr**** 628 gal/min
Lube Oil Cooler	3 (1 per diesel)	2,960,000 Btu/hr 298 gal/min
Governor Oil Cooler	3 (1 per diesel)	3,816 Btu/hr 1 gal/min
Air Intercooler	6 (2 per diesel)	2,991,066 to 4,781,066 Btu/hr @ 6,050 kW**** 2,246,800 to 4,036,800 Btu/hr @ 5,500 kW**** 560 gal/min
Engine-Driven Jacket Water Pump	3 (1 per diesel)	1350 gal/min @ 70 ft TDH
AC-Motor-Driven Jacket Water Standby Pump	3 (1 per diesel)	1350 gal/min @ 70 ft TDH 40 hp, 480 V, 3-phase, 60 Hz, 1750 rpm
AC-Motor-Driven Circulation Pump	3 (1 per diesel)	175 gal/min @ 40 ft TDH, 5 hp, 480 V, 3-phase, 60 Hz, 1750 rpm
Jacket Water Heater	3 (1 per diesel)	40 kW, 480 V, 3-phase, 60 Hz or 18 kW, 480V, 3-phase, 60 Hz

**** Maintaining full Jacket Water flow to the Intercooler Preheaters causes as much as 1,790,000 BTU/hr of total intercooler heat load to be transferred to the Jacket Water system.

TABLE 9.5.5-2

FAILURE MODES AND EFFECTS ANALYSIS FOR
THE STANDBY DIESEL GENERATOR(S)

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect On System Safety Function Capability	General Remarks
Level instruments in fuel oil storage tanks	None	1-5	No signal	Redundant level indication	None - Redundant level controls available	There are two additional redundant diesel generators
Compressor check valve (XSD003A, 4A, 3B, 4B, 3C, or 4 C)	Closed, maintain pressure	1-5	Leaks	Low pressure alarm	None - Redundant receiver and check valves available	There are two additional redundant diesel generators
Starting air receiver	Provide high pressure air and start diesel	1-5	Loss of air	Low pressure alarm	None - Redundant receiver available	There are two additional redundant diesel generators
Auxiliary skid components, e.g.: a) jacket water cooler b) lube oil cooler c) pumps d) inter-coolers	Support diesel generator by supplying listed functions	1-5	One supporting function fails	Common alarm in main control room with individual functions indicated on the main/local panels	None - Two additional redundant diesel generators available to provide the necessary emergency power	
Fuel Oil Recirculation Piping	None	1-5	Pipe break due to seismic event	Seismic monitors, FOST level	Fuel lost is included in minimum storage requirement	Use of recirculation piping during potential tornado or hurricane conditions is controlled administratively

* Plant Modes

1. Power Operation
2. Startup
3. Hot Standby
4. Hot Shutdown
5. Cold Shutdown
6. Refueling

TABLE 9.5.5-2 (Continued)

FAILURE MODES AND EFFECTS ANALYSIS FOR
THE STANDBY DIESEL GENERATOR(S)

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect On System Safety Function Capability	General Remarks
Diesel generator	Start	1-5	Stops or fails to deliver adequate power	Load indication in main control room	None - Two additional redundant diesel generators available to provide the necessary emergency power	
Inlet air filter	None - Provides clean air	1-5	Clogs	Stalls alarm for high differential pressure	None - Two additional redundant diesel generators available to provide the necessary emergency power	
Channel I DC Power (Train A)	Provide DC control power for the diesel	1-5	Loss of DC power	ESF monitoring on UPS failure, DC trouble alarm	None	Two additional redundant trains provide system safety capability
Channel III DC Power (Train B)	Provide DC control power for the diesel	1-5	Loss of DC power	ESF monitoring on UPS failure, DC trouble alarm	None	Two additional redundant trains provide system safety capability
Channel IV DC Power (Train C)	Provide DC Power for the diesel	1-5	Loss of DC power	ESF monitoring on UPS failure, DC trouble alarm	None	Two additional redundant trains provide system safety capability
Exhaust	None	1-5	Clogs	Engine stalls	None	Two additional redundant diesels available

* Plant Modes

1. Power Operation
2. Startup
3. Hot Standby
4. Hot Shutdown
5. Cold Shutdown
6. Refueling

TABLE 9.5.5-3

DIESEL GENERATOR COOLING WATER SYSTEM
INDICATIONS AND ALARMS

Parameter	Local	Engine Control Panel (local)	Main Control Room	Comments
Cooling Water Pressure (closed loop)	Gauge (Engine-Driven Jacket Water Discharge)			
	Gauge (AC-Motor-Driven Jacket Water Standby Pump Discharge			
	Gauge (Circulation Pump Discharge			
	Gauge (inlet to the engine)	Alarm (Low Pressure)	Common trouble Alarm*	Pressure switch provides auto start of standby pump on low pressure
		Gauge (Jacket Water)		
Cooling Water Temperature (closed loop)	Gauge (Jacket Water Cooler Inlet)			
	Gauge (Engine Inlet Header)			Temperature switch controls circulation pump & electric heater
Cooling Water Temperature (closed loop)	Gauge (Engine Discharge)	Alarm (low temp)	Common trouble alarm*	Temperature switch provides engine shutdown on high temperature
		Alarm (high temp)	Common trouble alarm*	
Cooling Water Level	Gauge (Jacket Water Stand-Pipe)	Alarm (low level)	Common trouble alarm*	
		Alarm (high level)		

* Denotes single window for common trouble alarm

TABLE 9.5.5-3 (Continued)

DIESEL GENERATOR COOLING WATER SYSTEM
INDICATIONS AN DALALARMS

Parameter	Local	Engine Control Panel (local)	Main Control Room	Comments
Cooling Water Temperature (Essential Cooling Water)	Gauge (Governor Oil Cooler and Intercooler Inlet)			
	Gauge (Governor Oil Cooler and Intercooler Outlet)			

TABLE 9.5.5-4

POWER SOURCES FOR DG JACKET WATER PUMPS AND HEATER

Standby Diesel Generator	AC-Motor-Driven Circulation Pump	Heater	Jacket Water Standby Pump
11	MCC E1A1	MCC E1A1	MCC E1A1
12	MCC E1B1	MCC E1B1	MCC E1B1
13	MCC E1C1	MCC E1C1	MCC E1C1

TABLE 9.5.6-1

DIESEL GENERATOR STARTING SYSTEM
DESIGN DATA

Equipment	Quantity Per Unit	Data
AC motor air compressor	6 (2 per diesel)	32.2 ft^3/min, 15 hp, 460 V, 3-phase, 60 Hz
Air receiver	6 (2 per diesel)	Volume: 83 ft^3, maximum Operating pressure 250 psig

Diesel Generator	Air Compressor No.	Power Source
11	11	MCC – 1A5
11	12	MCC – 1A5
12	13	MCC – 1B5
12	14	MCC – 1B5
13	15	MCC – 1C5
13	16	MCC – 1C5

TABLE 9.5.6-2

DIESEL GENERATOR STARTING AIR INDICATIONS & ALARMS

Parameter	Local	Engine Control Panel (Local)	Main Control Room	Comments
Starting Air Pressure	Gauge (Air Receivers)	Gauge (Air Receivers)	Gauge (Air Receivers)	
	Low Pressure Switch	Alarm (Low Pressure)	Common trouble alarm	
	Low Pressure Switch	Alarm (starting air valve malfunction R/H bank)	Common trouble alarm	
	Low Pressure Switch	Alarm (starting air valve malfunction L/H bank)	Common trouble alarm	
	High/Low Pressure Swich			Start/Stop compressors
	High Pressure Switch	Alarm (high starting air pressure – right bank)	Common trouble alarm	
	High Pressure Switch	Alarm (high starting air pressure – left bank)	Common trouble alarm	

TABLE 9.5.7-1

DIESEL GENERATOR LUBRICATION SYSTEM
SYSTEM DESIGN DATA ALARMS

Equipment	Quantity per Unit	Type or Capacity
Engine-driven lube oil pump	3 (1 per diesel)	670 gal/min @ 90 psig
Lube oil strainer	6 (2 per diesel)	Basket type, 150 mesh wire screen, 304SS
Lube oil filter	3 (1 per diesel)	Full flow, replaceable element type, 16 microns
Lube oil cooler	3 (1 per diesel)	Shell and tube type
AC-motor-driven circulation lube oil pumps	3 (1 per diesel)	120 gal/min at 50 psig 15 hp, 460 V, 3-phase, 60 Hz
AC-motor-driven lube oil standby pumps	3 (1 per diesel)	670 gal/min @ 90 psig 60 hp, 460 V, 3-phase, 60 Hz
Lube oil heater	3 (1 per diesel)	19 kW, 480 V, 3-phase, 60 Hz, or 12 kW, 480 V, 3-phase, 60 Hz

Diesel Generator	AC-Motor-Driven Circulation Lube Oil Pump Power Source
11	MCC – E1A1
12	MCC – E1B1
13	MCC – E1C1
	AC-Motor-Driven Circulation Lube Oil Standby Pump - Power Source
11	MCC – E1A1
12	MCC – E1B4
13	MCC – E1C1

TABLE 9.5.7-1 (Continued)

DIESEL GENERATOR LUBRICATION SYSTEM
SYSTEM DESIGN DATA

Diesel Generator	Lube Oil Heater – Power Source
11	MCC – E1A1
12	MCC – E1B1
13	MCC – E1C1

TABLE 9.5.7-2

DIESEL GENERATOR LUBE OIL INDICATIONS AND ALARMS

Parameter	Local	Engine Control Panel (Local)	Main Control Room	Comments
Lube Oil Pressure	Gauge (Engine-Driven Lube Oil Pump Discharge)			
	Gauge (AC-Motor-Driven Lube Oil Standby Pump Discharge)			
	Gauge (AC-Motor-Driven Circulation Pump Discharge)			
	Gauge (Inlet Press. To Turbocharger)	Gauge (Inlet Pressure To Turbocharger)		
	Gauge (Lube Oil Main Header)	Gauge (Lube Oil Main Header)	Gauge (Lube Oil Main Header)	
	Low Pressure Switch Main Header	Alarm, low pressure	Common trouble alarm	Low pressure will shut down the diesel in a nonemergency operation
	Low Pressure Switch Inlet to Turbocharger	Alarm, low pressure	Common trouble alarm	
	Gauge (Inlet to Lube Oil Filter)			
	Gauge (Outlet from Lube Oil Filter and Inlet to Lube Oil Strainer)			
	Gauge (Outlet from Lube Oil Strainer			

TABLE 9.5.7-2 (Continued)

DIESEL GENERATOR LUBE OIL INDICATIONS AND ALARMS

Parameter	Local	Engine Control Panel (Local)	Main Control Room	Comments
	Gauge (Lube Oil Filter Differential Pressure)	Alarm (High Differential Pressure)	Common trouble alarm	
	Gauge (Lube Oil Strainer Differential Pressure)	Alarm (High Differential Pressure)	Common trouble alarm	
	Gauge (Crankcase Pressure)	Alarm (high pressure)	Common trouble alarm	
Lube Oil Temperature	Gauge (Pump Discharge Header-Engine Supply)	Alarm (high oil Temperature)	Gauge Common trouble alarm	
	Gauge (Lube Oil Cooler Outlet)			
	Gauge (Lube Oil Main Header)	Alarm (low oil Temperature)	Common trouble alarm	Temperature controller operates heater at 120°F falling
Lube Oil Level	Gauge (Engine Crankcase)	Alarm (low level)	Common trouble alarm	
		Alarm (high level)	Common trouble alarm	

APPENDIX 9A

Assessment of the Potential Effects of Through-Wall Cracks in ECWS Piping

Introduction:

STPEGS identified through-wall cracks in the STP Essential Cooling Water System piping which were initiated by preexisting weld defects and propagated by a dealloying phenomenon. The flaws evaluated appeared in welds with backing rings.

STPEGS has analyzed the effects of the cracking and found that the degradation is slow so that rapid or catastrophic failure is not a consideration, and determined that the leakage can be detected before the flaw reaches a limiting size that would affect the operability of the ECWS. A monitoring and inspection program provides confidence in the ability to detect the leakage.

> Leaks that are detected are treated as non-conforming to the ASME Code, Section XI, i.e., as temporary non-code conditions in accordance with Generic Letter 90-05. Relief Requests are submitted to the NRC for such leaks (except for repairs in accordance with Code completed during LCO conditions, or leaks detected and repaired during an outage. Leaks are repaired to meet Code within the time limits specified in Generic Letter 90-05. The temporary non-code conditions is justified for operability in accordance with fracture mechanics and limit load methods consistent with ASME Code, Section XI methodology which was presented to the NRC (Ref. 12 and 13). CN-3073

Potential Effects of Leakage:

The potential effects of leakage from the ECW pipe defects include:

1) Internal flooding in rooms containing these pipes and other rooms which receive drains from these sources.

2) Electrical shorts or grounds caused by water spray from the crack.

3) Reduction in ECW flow through the heat exchangers served by the affected ECW train.

4) Water losses from the ECP not accounted for in the existing analysis.

5) Possible effects on the transient pressures when the pump is started or stopped.

Evaluation of these effects requires consideration of the structural integrity of the pipe. i.e., is it possible for the crack or dealloyed area to grow to the point of rapid failure or plastic collapse. It should be noted that the dealloying phenomena is a slow process that develops over a long period of time.

SAFETY ANALYSIS

Structural Integrity of Welds:

The weld population consists of shop welds made by Southwest Fabricating Co. without backing rings, field welds made by Brown & Root without backing rings, and field welds made by Ebasco and HL&P with backing rings. All welds that have shown through-wall cracks have been Ebasco welds with backing rings. Laboratory failure analysis data (Ref. 14 and 15) has indicated that in the cases that leaked, a preexisting crack penetrating into the central core of the weld was present. Poor fit-up may have contributed to such root pass cracking. Crack growth appears to have occurred by a process of the crack tip dealloying locally and the crack propagating through the dealloyed zone. Crack growth after the appearance of leakage is a slow process.

Reference 12 and 13 provide generic analytical methods used for structural integrity analysis and worst case margin information for the backing ring welds as a population. In practice, the system is monitored regularly, and any through wall leaks that occur are classified as temporary non code conditions and processed in accordance with the methodology of Generic Letter 90-05. Relief requests are filed with the NRC (except for leaks that are repaired in Tech. Spec. LCO conditions, leaks that are detected and repaired during an outage. Operability for the temporary condition is evaluated using the methods of Reference 12, which are consistent with the methodology of ASME Code Section XI, and using the stresses for the leaking location. CN-3073

Generic Issue -- Other Welds:

The above ground large bore welds are presently monitored for leakage by walk downs on a periodic basis. The below ground items are also being monitored on a periodic basis by a walkdown of the ground condition above the pipe layout in the yard. Cracks large enough to approach the crack size for failure should be noticeable through soil changes which can be detected by walk downs. Where such a change is observed, it is possible to excavate and monitor the location visually. The experience with other buried pipes at this site has been that significant leaks will eventually result in water seepage or springs at the ground surface.

Leakage of approximately 1000 gpm per train in the 30" piping can be accommodated without impacting the ability of the ECW system to perform its safety function. This flow would certainly be detected. Calculation (CC-5089) indicates that a leakage rate of 10 to 20 gpm is likely to raise the water in the trench to ground surface. Therefore, any significant leakage in the buried pipe would be detected. In addition, alarms and/or surveillances on the diesel would indicate reductions in flow which potentially could impact the ability of the diesel to perform its safety function.

Internal Flooding Mechanical Auxiliary Building:

The potential for flooding from internal sources in the MAB was analyzed in Reference 3. This analysis was performed in accordance with regulatory requirements contained in References 4 and 8. Potential leakage from a "Critical Crack", equivalent in area to a rectangle with a length of one-half the pipe diameter and a width one-half the pipe wall thickness, was assumed in turn for each pipe located in the room. Dealloying is a slow developing mechanism that results into a through wall seepage concern and is not expected to result in rapid pipe failure. Other possible sources of water, such as fire protection sprinklers and fire hoses, rupture of non-seismic designed tanks, and critical cracks in seismic designed tanks, are also considered.

In a worst case example, the subject pipe is 30" in outside diameter and has a wall thickness of 0.25". Thus, the critical crack size as defined in the Moderate Energy Line Break calculation is 15" in length by 0.125" in width. The flow rate calculated from a critical crack in one of the 30" ECW lines per Reference 3 was 57.9 cfm (433 gpm). This was not the limiting case of flooding in room 106. The worst case was flooding from an adjacent room (room 106A), caused by sprinklers and fire hose (2 inch) discharge at a rate of 107 cfm (800 gpm). The resulting water level in room 106 would be 2.5 inches.

Room 106 drains into a large area in the lowest elevation of the MAB. The worst case of flooding into this area was from the postulated rupture of a high energy line, which in turn could sever a fire protection line. This could result in a flooding rate of 5750 gpm, giving a total flooding volume of 172,500 gallons over the 30 minute period required to stop the flooding. The flooding results in 12.5 inches of water in the affected area.

Floor drains to 3 different sumps are available in room 106. Leakage from the crack could go into any of the following sumps: ECW Sump, MAB Sump #1, or CCW Sump. All of these sumps have high level alarms, which would alert the operator to leakage in excess of the sump pump(s) capacity. Sump pump capacities for these sumps are: ECW - 2 pumps at 390 gpm each; MAB #1 - 2 pumps at 50 gpm each; CCW - 1 pump at 75 gpm. The sump level switches are not safety-related, however, the alarms for MAB Sump #1 (and several other MAB sumps) receive back-up power from batteries which will be available for a minimum of 2 hours after a Loss of Offsite Power.

The three CCW pump/chiller rooms are part of the large area in the MAB receiving water from Room 106 and the ECW sump room. The possible flooding from the much larger 30" lines remains the limiting case.

The ECW Sump Room is one of the areas which receive drains from Room 106. The design flooding rate in this room is 57.9 cfm (433 gpm), which gave a maximum flood level in the room of 3 inches above the 18" curb in the doorway. From this room water would flow into the other rooms in the 10 foot elevation in the MAB as described above.

<u>Internal Flooding -- DGB</u>:

Flooding in the DGB can be tolerated up to a maximum water level in a diesel bay of 6807 gallons (ref calc CC-5038), which corresponds to a water level 4" above the floor. If for any reason the water level reaches that height, then at that time the diesel would be declared inoperable. Technical Specifications require three diesel generators to be operable in Modes 1-4 and two diesel generators to be operable in Modes 5 and 6. The DGB design precludes flooding in one bay from impacting the other two bays.

Plant operators monitor the diesel sump levels for increases which could be indicative of ECW leakage.

<u>Internal Flooding -- ECWIS</u>:

The potential for flooding from internal sources in the ECWIS was analyzed in Reference 10, and the effects of this flooding were analyzed in Reference 11. The maximum flooding rate was 72.9 cfm (545 gpm), which would flood the pump cubicle to a level sufficient to cause electrical grounds and trip the ECW Pump Motor in about 1.44 hours. With flooding as the initiating event, this is acceptable because the flooding cannot propagate to adjacent trains, and only train related equipment is located in the affected cubicle. The acceptable rate of flooding taken in conjunction with other initiating events is discussed later.

Spray Effects -- MAB:

The flow transmitters and MOV's are designed to operate in a spray environment. The CCW heat exchangers, CCW and ECW piping, and Essential Chilled Water system expansion and chemical addition tanks are mechanical components which would not be affected by water spray.

The ECW instrumentation in the ECW Sump Room is not safety-related or required for safe cold shutdown. The ECW Sump Pump is not safety-related and no credit is taken for its operation in any flooding analysis. The ECW blowdown isolation valves have a safety-related function to stop ECW blowdown on an SI signal. This valve fails closed on loss of power, spray could cause the valve to fail to the required position.

Spray Effects -- DGB:

Although there is safety-related and other equipment in the vicinity of the ECW piping, the pipe is oriented such that the equipment motors which are of the "open drip proof" class, would not be subjected to any direct spraying water or mist should a crack start spraying.

Spray Effects -- ECWIS:

There are a number of safety-related components in each pump cubicle which could be adversely affected by spray, including the ECW Pump Motor. If the crack is the initiating event, the loss of the train is acceptable, and no other train could be affected by the spray. To maintain operability for the unlikely occurrence of other initiating events, temporary measures may be required to prevent water spraying from a leak in the ECWIS.

Reduction in ECW Flow:

Additional flow through a 15" by 1/8" crack in a 30" pipe would increase ECW pump flow and thus decrease pump head and flow through all heat exchangers other than the CCW heat exchanger. The reduction in flow for a 545 gpm leak located upstream of the heat exchangers would be roughly 2%. A 2% flow reduction would not affect operation of any of the components served by the ECW system. Leakage from a location between the CCW heat exchanger and the balancing valve would have less effect on flow, while leakage from downstream of the balancing valve would have no effect on flow.

Water Losses from the ECP:

Reference 1 assumed total soil seepage losses of 1.2 cfs (539 gpm) from the ECP for the worst case 30 day period, without make-up. The worst case accident for maximum evaporation (simultaneous shutdown of both units) resulted in 4.0 feet of water remaining in the ECP. Preoperational testing attempted to measure the seepage by calculating or measuring other losses. The seepage was conservatively estimated as less than 0.3 cfs (135 gpm). The current method of testing seepage shows the total water losses from the ECP, including evaporation, are less than 1.2 cfs. Because the assumed seepage losses are conservative by at least 404 gpm, and because the analysis shows a great deal of margin exists in ECP water available, the losses from a 15" by 1/8" crack in the 30" ECW pipe is not of concern with respect to the ECP volume analysis.

Transient analysis:

Modification 90075 (Unit 1) and 90076 (Unit 2) installed vacuum breakers which resolved the hydraulic transients that were originally experienced. Therefore, hydraulic transients due to pump starts and stops were eliminated.

Combination with design basis accidents:

The flooding analysis described above was based on the pipe crack being the initiating event. The guidelines for this analysis differ from the assumptions required for design basis accidents. To show consistency with design basis accident analysis, it is necessary to demonstrate the ECW trains which contain the cracks are capable of operating for several days without degrading the performance of the ECW train or causing excessive flooding in the MAB.

The time required to complete compensatory actions after damage to non-safety systems differs, depending on the action required. Thirty days is assumed to restore make-up capability to the ECP after a DBA, while 7 days is a conservative assumption regarding the time required to provide a temporary pump to drain water from elevation 10 of the MAB. If the maximum leak rate is limited to 8 gpm, the total water accumulation in elevation 10 of the MAB over a 7 day period would be less than one-half the design basis flood accumulation.

The maximum flooding rate in the ECWIS should be limited to 2.3 gpm, based on allowing 7 days operation before providing temporary drainage and while allowing only one-half the design basis flood accumulation. CN-3092

Compensatory Action:

In order to promptly identify and evaluate future leaks, the accessible large bore piping welds with backing rings shall be visually inspected periodically for evidence of leakage. A walkdown of the yard above buried ECW pipe shall be performed periodically for evidence of soil changes.

For known leaks, the rate of leakage will be monitored for signs of increased leakage considering the total leakage for all leaks in the MAB, in the ECWIS and in the DGB. Significant increases in the leakage rate will be evaluated.

Leaks which produce a spray that potentially affects other safety-related components shall have a cover/deflector installed to divert the spray or will have other means of protecting safety-related components from the spray.

Any through wall leaks found are documented on a Non-conforming Condition Report, dispositioned, and repaired to meet the codes committed to in the Licensing basis within the time limits specified in Generic Letter 90-05. Relief Requests are filed with the NRC as required by Generic Letter 90-05. Each identified defect shall be individually evaluated for operability and documented on its identifying Condition Report.

Conclusion:

Structural integrity analysis shows that at the maximum stress locations in the piping, very large cracks would be required to cause sudden failure. Such large through wall cracks are expected to be detected well before they reach such large sizes. Any safety-related equipment sensitive to spray is protected, and flooding is not a concern. Any known leak is treated as a temporary non-code condition in accordance with Generic Letter 90-05. In the interim, its operability is evaluated in accordance with analytical methods consistent with ASME Code, Section XI, and the location is monitored. Therefore, the health and safety of the public are not jeopardized as a result of the condition.

References:

1. Essential Cooling Pond Thermal Performance Analysis at the South Texas Project Nuclear Power Plant, by NUS, vendor document # 0400-00012-BNU

2. Calculation Number HR-048, Rev. 0

3. Calculation Number NC-9703, Rev. 2, Flooding Analysis: MAB

4. Branch Technical Position ASB 3-1

5. Calculation Number NC-9712, Rev. 2, Facility Response Analysis for MAB Flooding and Spray Effects

6. Calculation Number NC-5108, Rev. 0, ECWS Hydraulic Transient Analysis

7. Bechtel Letter Number H&CF-L-S-979, dated June 30, 1986

8. Branch Technical Position MEB 3-1

9. Letter to the NRC ST-HL-AE-2748, dated November 1, 1988

10. Calculation Number MC-5216, Rev. 1, Flooding Analysis for the ECWIS

11. Calculation Number NC-9711, Rev. 1, Facility Response Analysis for ECWIS Flooding and Spray Effects

References: (continued)

12. Aptech Calculation AES-C-1630-2 "Calculation of Critical Bending Stress for Flawed Pipe Welds in the ECW System"

13. HL&P presentation to NRC dated March 13, 1992 (ST-HS-HS-19581)

14. HL&P Laboratory Report MT-3512A, "Evaluation of Cracked Elbow-to-Nozzle weld from South Texas Project Unit 1 Essential Cooling Water System"

15. HL&P Laboratory Report MT-3512B, "Evaluation of Cracked Aluminum Bronze Pipe-to-Pipe Weld from South Texas Project Unit 2 Essential Cooling Water System"

16. Modifications 90075 and 90076