SEABROOK STATION
UPDATED FINAL SAFETY ANALYSIS REPORT

CHAPTER 9
AUXILIARY SYSTEMS

9.1 FUEL STORAGE AND HANDLING

The design characteristics of the Fuel Storage Building and its ventilation systems are discussed in Subsections 3.8.4, 6.5.1 and 9.4.2. The facilities are designed to meet the appropriate requirements of NRC Regulatory Guides 1.13 and 1.29. All fuel handling equipment (cranes and other devices) are designed with adequate margin to safely handle the dead loads plus assumed dynamic loads. (See Subsection 9.1.4.)

9.1.1 New Fuel Storage

9.1.1.1 Design Bases

The new fuel storage facilities are located within the Fuel Storage Building and are designed to facilitate the safe handling, inspection and storage of new fuel assemblies and control rods. Space is provided for handling and storage of 90 new fuel assemblies, which is equal to a core load plus 25 spare assemblies.

The new fuel is stored dry in storage racks. These racks are designed to withstand a safe shutdown earthquake (SSE), impact, handling loads and dead loads of the fuel assemblies, as well as meet ANSI N18.2 requirements. The object used to determine the impact load for the design of the racks is a fuel assembly (17x17), 8.426 inches square, 167 inches long, and a control rod weighing a total of 1650 pounds, and falling a distance of 6 feet above the top of the rack at a worst possible angle. All other objects are smaller, lighter and have less energy. The storage racks and anchorages are designed to withstand the maximum (rated) load which can be imposed by the auxiliary hook on the cask handling crane without an increase in K_{eff}.

The racks are designed and administratively controlled to provide a storage arrangement which assures a margin of subcriticality even in the unlikely event the new fuel storage vault is flooded with unborated water or is sprayed with fire fighting foam or mist. The design margins of subcriticality of $K_{eff} \leq 0.95$ under flooded conditions and of $K_{eff} \leq 0.98$ under conditions of low density, optimum moderation, are maintained by limiting the loading to 90 assemblies of fuel with enrichment up to 3.675 w/o ^{235}U and reducing the loading to 81 assemblies for enrichments from 3.675 to 5.0 w/o ^{235}U by limiting the fuel assembly placement in the central column of the new fuel storage vault to every other location.

The new fuel racks are designed for a postulated stuck fuel assembly load that causes an upward drag force of 3500 pounds (approximately two times the combined weight of a fuel assembly and control rod) to be exerted on the assembly upon attempted withdrawal. New fuel rack design also requires that the deformation of the impacted storage cells not adversely affect the minimum spacing requirements of 21 inches.

Provisions have been made in the crane handling system, by providing load limit switches, to insure that the maximum uplift force specified for the design of new fuel rack is not exceeded, thus averting any increase in K_{eff}.

Protection of the new fuel storage facilities from wind and tornado effects is discussed in Section 3.3. Flood protection is discussed in Section 3.4.

Missile protection is discussed in Section 3.5. Protection against fire hazards is discussed in Subsection 9.5.1.3. Radiation monitoring is provided to meet the requirements of 10 CFR 50, Appendix A, GDC 63. The radiation monitor is a GM tube-based area monitoring channel. The high range detector is an ion chamber. An alarm is initiated in the control room when the radiation level exceeds a predetermined setpoint (see Table 12.3-14). Details of the Radiation Monitoring System are provided in Subsection 12.3.4.

9.1.1.2 Facilities Description

The new fuel storage facilities are located adjacent to the spent fuel pool in the Fuel Storage Building to permit ease of handling of the new fuel into the transfer canal. The arrangement of the new fuel storage facilities is shown on Figure 1.2-15, Figure 1.2-16, Figure 1.2-17, Figure 1.2-18, Figure 1.2-19, Figure 1.2-20 and Figure 1.2-21.

The storage vault is a rectangular concrete room containing the new fuel storage racks which securely hold the new fuel in a vertical position.

The storage racks are individual vertical cells that are fastened together to form a module. All surfaces of the racks that come into contact with fuel assemblies are made of austenitic stainless steel, whereas the supporting structure is painted carbon steel.

The racks are constructed so that it is impossible to insert fuel assemblies anywhere in the storage vault except where holes are provided. The holes have a minimum center-to-center spacing of 21 inches in both directions which is sufficient to maintain the design margins of subcriticality, $K_{eff} \leq 0.95$ under flooded conditions and $K_{eff} \leq 0.98$ under conditions of low density, optimum moderation. These criticality safety margins are maintained by limiting the loading to 90 assemblies of fuel with enrichment up to 3.675 w/o ^{235}U and reducing the loading to 81 assemblies for enrichments from 3.675 to 5.0 w/o ^{235}U by limiting the fuel assembly placement in the central column of the new fuel storage vault to every other location.

New fuel assemblies are delivered to the station in new fuel shipping containers. These containers are off-loaded from the transport vehicle in the Fuel Storage Building where the fuel assemblies are removed, inspected and stored in the new fuel storage vault.

The new fuel is transported from the unloading zone to the storage vault and to the new fuel elevator by the 5-ton hook on the cask handling crane. Security of new fuel is maintained by controlled access to the Fuel Storage Building.

9.1.1.3 Safety Evaluation

The new fuel storage facility is designed to utilize wide spacing between assemblies to prevent criticality. The 21" minimum center-to-center spacing is sufficient to maintain $K_{eff} \leq 0.95$ with uncertainties, when flooded with unborated water and loaded with fuel of enrichment up to 5.0 w/o ^{235}U. Thus, even though the new fuel is stored dry, flooding with unborated water will not produce criticality. However, the wide spacing in the new fuel vault leads to peaks in reactivity under conditions of low water density, 0.1 to 0.05 g/cc, or "optimum moderation." The criticality safety limits on maximum fresh fuel enrichment and maximum number of assemblies are defined at the "optimum moderation" condition with $K_{eff} \leq 0.98$ with uncertainties. In order to maintain this limit, full loading of 90 assemblies with fuel enrichment up to 3.675 w/o ^{235}U is permitted, but the loading must be reduced to 81 assemblies for enrichments from 3.675 to 5.0 w/o ^{235}U by limiting the fuel assembly placement in the central column of the new fuel storage vault to every other location.

a. New Fuel Vault Description

The new fuel storage vault is a temporary storage area for fresh, unirradiated fuel. Assemblies can be arranged in a 5 x 18 array with a 21" minimum center-to-center spacing (see Figure 9.1-13). Assemblies are held in place at top and bottom by grids which provide the necessary center-to-center spacing. The vault is surrounded by one-foot-thick concrete walls with the outer row of assemblies one foot away from the walls. Criticality control in the vault is essentially by wide separation between assemblies. The space between and within assemblies is normally air (void). Moderator is introduced only by abnormal situations, such as fires, which require fire fighting foam or water mist. Since the intrusion of water by foam or mist cannot be totally precluded, the criticality of the vault is studied as a function of moderator density with particular emphasis on conditions of low density, 0.1 to 0.05 g/cc, or "optimum moderation."

b. Method of Analysis

The criticality analysis for the new fuel vault was done with the NITAWL-S/KENO-Va Monte Carlo method in 123 neutron energy groups. The NITAWL-S code prepares a working nuclide library and performs resonance self-shielding for ^{238}U. The working nuclide library along with case-specific compositions and rack geometry data is input to KENO-Va. KENO-Va performs a multi-group, Monte Carlo eigenvalue calculation for the fuel vault model.

The KENO-Va model of the fully loaded new fuel vault involves a basic unit of analysis which includes the concrete wall, floor and three partial assemblies (see Figure 9.1-14). This model allows axial leakage with reflection from the floor and radial leakage with reflection from the walls. However, the model is infinite in the 18 canister direction. Since results show that fuel only up to 3.675 w/o ^{235}U can be allowed in the fully loaded vault at "optimum moderation," two other KENO-Va models are developed to study partial loading of the vault with higher fresh fuel enrichments.

The KENO-Va models of the partially loaded new fuel vault are shown in Figure 9.1-15 and Figure 9.1-16. In the first model, the central column of the 5 canister direction is left empty. Even though the model is infinite in the 18 canister direction, the model implies a maximum capacity of 72 assemblies in new fuel vault. In the second model, the central column has alternating empty and loaded locations. Again, even though the model is infinite in the 18 canister direction, the model implies a maximum capacity of 81 assemblies in the new fuel vault.

c. Results

K_{eff} as a function of void for the fully loaded new fuel vault is shown in Figure 9.1-17. The assemblies are 3.5 w/o ^{235}U in enrichment. Moderator is introduced uniformly throughout all pin cells, guide tube cells, assembly upper and lower reflector regions and the inter-assembly gap regions. The flooded condition or 0% void corresponds to water at 68°F or 0.9982 g/cc, and 100% void is the dry condition. Figure 9.1-17 shows that vault K_{eff} at 0% void is at about 0.89. Vault K_{eff} decreases steadily with void until a minimum is reached at 65%, 0.35 g/cc. After which there is a sharp increase in K_{eff} with a peak at 95% void, 0.05 g/cc, and then a rapid drop in K_{eff} at 100% void, dry.

The behavior of K_{eff} can be understood if one considers that there are two types of moderation occurring in the vault: moderation between assembly pin cells and moderation in the space between assemblies. The former type of moderation dominates the criticality of the array in high density situations, and the latter dominates in low density situations. This second type of moderation can produce large increases in reactivity. The moderator density at which the peak occurs is called "optimum moderation." In the Seabrook new fuel vault, "optimum moderation" occurs at 95% void or about 0.05 g/cc of water. For 3.5 w/o ^{235}U fuel assemblies K_{eff} is still below the limit of 0.98. Also, in a fully flooded condition, the K_{eff} is considerably below 0.95. The optimum moderator density of 0.05 g/cc of water is the most limiting condition.

K_{eff} of the vault vs. loading and enrichment is shown with uncertainties in Figure 9.1-18. From Figure 9.1-18, it can be seen that the fully loaded vault, 90 assemblies, has an enrichment limit of 3.675 w/o ^{235}U. Also, Figure 9.1-18 shows that either partial loading arrangements, 72 or 81, will allow fuel with enrichment up to 5.0 w/o ^{235}U under conditions of "optimum moderation."

The Fuel Storage Building is a seismic Category I building with an operating floor five feet above grade. There is a six-inch curb around the storage area to prevent any spillage onto the operating floor from flowing into the storage area. However, if water were to get into the storage area, the floor slopes down toward the new fuel upending area, and it would be removed by redundant 50 gpm sump pumps. Adequate spacing at the top of the fuel racks will preclude criticality resulting from placing a fuel element on the top of the rack. Grill work between rows of fuel racks provides a positive mechanical method of preventing insertion in positions not designated for fuel storage. Spaces between elements within the rack have physical barriers to prevent insertion of elements between fuel positions.

The new fuel storage facilities (storage vault and racks) are designed to maintain the fuel spacing during a safe shutdown earthquake (SSE). All critical components (walls, racks) are designed to meet seismic Category I requirements. (See Section 3.7 and Subsection 3.8.4.)

The cask handling crane and the spent fuel bridge and hoist are designed in compliance with Crane Manufacturer Association of America (CMAA) Specification 70, "Specification for Electric Overhead Traveling Cranes," 29 CFR 1910 and 29 CFR 1923 requirements. The cask handling crane bridge and the spent fuel bridge and hoist are not seismic Category I components; however, in compliance with Regulatory Position C.2 of Regulatory Guide 1.29, the cranes' design parameters are specified to provide adequate quality control of fabrication and control of design so that in the event of a DBE or SSE, the cranes will not fail in such a manner as to reduce the functioning of any plant feature designated as seismic Category I by Regulatory Guide 1.29. The cask handling crane trolley frame and main hoist machinery required to hold the load are classified as seismic Category I. Other components mounted on the trolley are seismically mounted in compliance with Regulatory Position C.2 of Regulatory Guide 1.29. The cranes are prevented from being dislodged off their rails during the SSE by mechanical anti-derailing devices. Figure 1.2-17 and Figure 1.2-18 show the space envelope, boundaries and limits of hook travel of the cranes.

9.1.2 Spent Fuel Storage

The safety function of the spent fuel pool and storage racks is to maintain the spent fuel assemblies in a subcritical array during all credible storage conditions, and to provide a safe means for cask loading of the assemblies.

9.1.2.1 Design Bases

a. The spent fuel pool storage facility is designed in accordance with Regulatory Guide 1.13.

b. The spent fuel pool is divided into two regions with twelve free standing and self-supporting modules (see Figure 9.1-19). Region 1 has six modules with BORAL as the neutron absorber that allows space for 576 fuel assemblies. Region 2 has six modules with BORAFLEX that allows space for 660 fuel assemblies. The maximum pool capacity is 1236 assemblies.

c. Total fuel assembly storage capability is based on fuel storage cell geometry, center-to-center distance, lead-in angle requirements and poison thickness.

d. The Region 1 spent fuel racks are designed for high density fuel storage and contain BORAL as a neutron absorbing material to assure a $K_{eff} \leq 0.95$. The Region 2 spent fuel racks contain BORAFLEX as a neutron absorbing material to assure a $K_{eff} \leq 0.95$. Both Region 1 and 2 analyses assume the fuel is immersed in unborated water.

e. The mechanical design of the spent fuel pool storage racks is such that spent fuel assemblies cannot be inserted in other than designated locations. This mechanical design and the restrictions outlined in Figure 9.1-22 prevent any possibility of accidental criticality.

f. A minimum of 10'-0" of water above the highest fuel element position is provided to permit fuel handling without exceeding a radiation dose of 2.5 mr/hr at the surface of the pool. The concrete walls provide adequate radiation protection from irradiated fuel assemblies.

g. The impact load for the design of the racks is based on a 17x17 fuel assembly with attached spent fuel handling tool, weighing 2100 pounds, and falling a distance of 18 inches to the racks at the worst possible orientation. A 2100 pound load limit cutout in the hoist circuit (normal mode) prevents the crane from moving loads in excess of 2100 pounds over stored fuel.

h. The facility and the building in which it is housed are capable of withstanding the effects of extreme natural phenomena, such as the SSE, tornadoes, hurricanes, missiles and floods.

i. The spent fuel storage racks have been designed to withstand an SSE, impact, handling loads, and dead load of the fuel assemblies, as well as meet ANSI N18.2 requirements.

j. The design of the spent fuel racks incorporates the capability for a postulated stuck fuel assembly load that causes an upward drag force of 5000 pounds to be exerted on the assembly upon attempted withdrawal. The rack design will preclude excessive deflections which would reduce spacing between assemblies or prevent removal of a spent fuel assembly.

k. The pool walls, fuel storage racks and other critical components whose failure could cause criticality, loss of cooling or physical damage to fuel, are classified as seismic Category I.

l. Failure of nonsafety-related systems or structures located in the vicinity of the spent fuel storage facility which are not designed to seismic Category I requirements will not cause an increase in K_{eff} that would result in the maximum allowable value being exceeded.

m. The spent fuel pool bridge and hoist is designed to remain on its rails during an SSE and, therefore, cannot damage stored fuel.

n. The crane handling system is designed to prevent excessive forces from being applied to the spent fuel storage racks.

o. Provisions have been made in the spent fuel crane handling system, by providing load limits to insure that the maximum uplift force specified for the fuel rack design is not exceeded, thus averting any increase in K_{eff}. The hoist control circuit is interrupted when the force exerted to raise the fuel assembly from its seated position exceeds 2500 pounds, and the hoist brake is then automatically set.

9.1.2.2 Facilities Description

The spent fuel storage and handling facility consists of four major areas: (1) the spent fuel pool, (2) the fuel transfer canal, (3) the spent fuel cask loading area and (4) a decontamination area. This arrangement is shown in Figure 1.2-15, Figure 1.2-16, Figure 1.2-17, Figure 1.2-18, Figure 1.2-19, Figure 1.2-20 and Figure 1.2-21.

The spent fuel pool is a water-filled cavity designed to safely store irradiated fuel assemblies. This pool is constructed of reinforced concrete, with all interior surfaces lined with stainless steel.

The fuel storage area is protected against external tornado missiles by 2-foot thick reinforced concrete walls. The large roll-up door on the west wall of the Fuel Storage Building is not designed for tornado missiles; however, a missile wall is provided inside the building to prevent any missiles that could possibly penetrate the roll-up door from reaching the storage pool or cooling equipment.

The elevation of the vehicle loading/unloading area is 20'-6". Protection against flooding is assured since the pool operating floor level elevation is at 25'-0", which is above any postulated flooding conditions resulting from any potential ponding on the site due to extreme rain and wave overtopping.

The storage racks which hold the spent fuel assemblies are modular units, and each unit is freestanding.

The spent fuel pool is separated from the fuel transfer canal by a concrete shielding wall with a gate to facilitate the transfer of fuel assemblies. Location of the gate is shown on Figure 1.2-16. The fuel transfer canal contains the necessary equipment to transfer the fuel assemblies to and from the reactor containment. This equipment includes: (1) a fuel transfer system conveyor car, (2) fuel transfer valve, (3) fuel transfer system lifting frame equipment, (4) fuel transfer system control panel, (5) new fuel elevator, and (6) portions of the Spent Fuel Pool Bridge Crane control console. The operation of this equipment is discussed in Subsection 9.1.4.

Isolation of the fuel transfer canal from the spent fuel pool by the gate provides a means for dry maintenance of the refueling equipment.

The cask loading pit is located next to the fuel transfer canal. This provides for submerged loading of spent fuel. The location eliminates the need to move heavy cask components over either new or spent fuel storage areas. The cask-handling crane is located so that its path of travel does not pass over the spent fuel pool. The cask is lowered from the operating floor level of 25' to the loading position on the platform located at the bottom of the pool at elevation (-)18'-5 ½" (top of platform).

The spent fuel assemblies are handled by a long-handled tool suspended from an overhead hoist and manipulated by an operator standing on the movable bridge over the pool. A minimum of 10'-0" of water exists during fuel handling operations to provide radiation protection to the operator.

The hoist on the spent fuel pool bridge is equipped with a load cell and Programmable Logic Controller (PLC) to prevent excessive loading and to advise the operator if the fuel assembly is caught in the storage rack. This load cell has adequate sensitivity to detect an abnormal binding condition and thus prevent the movement of the entire rack. If the load to raise the fuel assembly clear from its seated position exceeds a preset limit of 2,500 lbs., the hoist control circuit is interrupted and the brakes set. The 2,500 lbs. limit is set by the PLC and also by an overload setting in the hoist control circuit.

The spent fuel cask decontamination area is used for the storage, maintenance, cleaning, and decontamination of spent fuel transfer casks, the dry shielded canisters and dry fuel storage system transfer cask. This area can also be used for the temporary storage of other contaminated components.

Decontamination and maintenance procedures may require the use of portable scaffolds or elevated platforms to gain access to the upper parts of the cask. The decontamination area is provided with electricity, plant air, fresh water, demineralized water, steam and adequate drainage for the decontamination washdown water. This area is located between the transport vehicle loading area and the cask loading pool.

The spent fuel pool is monitored for leakage by a series of leak detection channels located adjacent to each liner seam weld. The Leak Monitor System has three channels which will gravity drain to a sump located in the Fuel Storage Building. This zoning arrangement can be used to aid in establishing the location of the leakage. By monitoring the leakage rate, any change in the integrity of the liner can be established.

9.1.2.3 Safety Evaluation

The Regions 1 and 2 spent fuel racks are designed to prevent criticality by use of the flux trap principle between adjacent storage canisters and by the neutron absorbers built into the canisters. The criticality safety limits must be sufficient to maintain $K_{eff} \leq 0.95$ at a 95/95 probability/confidence level, including uncertainties. These safety limits for the spent fuel racks are determined at 68°F no soluble boron conditions. Placement of fresh fuel with enrichments up to 5.0 w/o^{235}U can be made by administrative controls which allow credit for fuel assembly burnup and by checkerboarding of fresh fuel with burnt fuel.

a. Spent Fuel Rack Description

The Seabrook Station spent fuel pool contains twelve free-standing and self-supporting modules allowing space for 1236 fuel assemblies (see Figure 9.1-19). Each rack module comprises fuel storage cells with a center-to-center spacing of 10.35" (see Figure 9.1-20). There are 576 Region 1 and 660 Region 2 storage cells. Each storage cell is welded to a grid base and welded together at the top through an upper grid to form an integral structure (see Figure 9.1-21). Criticality control is by the flux trap principle; fast neutrons leaking from stored assemblies are thermalized in the water gap between cells and are then absorbed in the poison sheets.

b. Method of Analysis

The criticality analysis for the spent fuel racks was done with the CSAS25 option of SCALE 4.3 (BONAMI, NITAWL-II and KENO V.a Monte Carlo, CASMO-3 integral transport and CASMO-3/SIMULATE-3 nodal diffusion theory. KENO V.a was used to verify the CASMO-3 spent fuel rack criticality results and perform the accident analysis. CASMO-3 was used to determine rack K_{eff} vs. fresh fuel enrichment, unit cell sensitivity to mechanical perturbations and rack K_{eff} vs. burnup. Also, CASMO-3 was used to generate homogenized two group cross sections for nodal burnup credit analysis using SIMULATE-3. Two-dimensional checkerboard and three-dimensional axial fuel rack criticality analysis was performed with SIMULATE-3.

c. Results

CASMO-3 and KENO V.a fuel storage rack K_{eff} vs. enrichment comparisons are made. Both sets of calculations are at nominal mechanical dimensions, 68°F system temperature and no soluble boron.

The agreement between CASMO-3 and KENO V.a is excellent over the range of enrichment from 1.6 to 5.0 w/o ^{235}U. This agreement establishes the validity of the CASMO-3 fuel storage rack model and reactivity at high enrichments.

Calculation of K_{eff} at a 95/95 probability/confidence level requires an evaluation of reactivity effects of the mechanical uncertainties associated with a particular rack and fuel assembly design. CASMO-3 is used to determine the sensitivity of both rack designs to these mechanical uncertainties. The root-sum-of-squares mechanical uncertainty is then calculated for each rack design.

A determination of maximum fresh fuel enrichment without administrative controls is made by adding all uncertainties to the nominal K_{eff} values vs. enrichment and then solving for the enrichment at which K_{eff} = 0.95, the NRC limit.

K_{eff} is calculated at 95/95 probability/confidence level by the following equation:

$$K_{95/95} = K_{nom} + \sqrt{(\Delta K_c)^2 + (\Delta K_m)^2}$$

where:

K_{nom} = K_{eff} of the nominal configuration,

ΔK_{cb} = calculational bias,

ΔK_c = 95/95 calculational uncertainty, and

ΔK_m = 95/95 mechanical uncertainty.

In order to determine the amount of burnup necessary to get burnt fuel with enrichment higher than that calculated above (maximum fresh fuel enrichment without administrative controls) in the spent fuel racks, single assembly CASMO-3 hot full power depletion calculations and insertion into rack geometry were performed for fuel enrichments up to 5.00 w/o ^{235}U. All burnup calculations were performed at hot full power average conditions with restarts to rack geometry at 68ºF, no xenon, no soluble boron conditions. A maximum reactivity acceptance line based on the 0.95 NRC limit minus uncertainties as a function of burnup is calculated. The uncertainties as a function of burnup include the total uncertainty and an axial burnup dependent component which increases with burnup. The intersection of rack K_{eff} vs. burnup for each enrichment with the maximum reactivity acceptance line defines the minimum assembly burnup necessary to meet 0.95 with all uncertainties. These enrichment/burnup combinations are plotted to define the single unit (infinite array) burnup credit acceptance criterion. This criterion defines two regions: a region of acceptable burnup and enrichment for placement in the racks and a region of unacceptable burnup and enrichment. The enrichment/burnup combinations are plotted in Figure 9.1-22 as the lower limiting line. This defines the final burnup credit Technical Specification. Since this criterion is based on an infinite array assumption, it is conservative. The fuel assemblies with characteristics in the region of unacceptability can be made acceptable by checkerboarding this fuel with fuel of lower enrichment and/or higher burnup.

In order to determine fuel with enrichment and/or burnup that can be placed next to 5.0 w/o ^{235}U fuel, a series of fresh fuel and burnt fuel checkerboard cases are executed with SIMULATE-3. The fresh fuel is set at a maximum of 5.0 w/o ^{235}U. The burnt fuel is varied in initial enrichment and assembly burnup. Based on the checkerboard unit reactivity, a second line of demarcation is defined allowing the maximum permissible enrichment/burnup combinations to be checkerboarded with up to 5.0 w/o ^{235}U.

The SIMULATE-3 checkerboard K_{eff} vs. burnup at various initial enrichments are generated. The intersection of the checkerboard K_{eff} vs. burnup for each initial enrichment with the maximum reactivity acceptance line yields the minimum alternate assembly burnup necessary to meet K^{eff} with uncertainties $\leq$0.95. These alternate enrichment/burnup combinations are plotted in Figure 9.1-22 as the upper limiting line. Figure 9.1-22 defines the final burnup credit and checkerboarding Technical Specification. This Technical Specification defines three Types of Fuel: 1, 2 and 3 and the following conditions hold for the Seabrook spent fuel racks:

1 may be stored anywhere,

2 must not be stored next to 3, and

3 must be stored next to 1 or empty locations.

d. Abnormal Configurations

Abnormal configurations include misloading of a fuel storage rack with fresh fuel of 5.0 w/o ^{235}U enrichment, an assembly dropped on top of the rack, and an assembly next to the outside of the racks. Credit is allowed for the presence of soluble boron (2000 ppm) in abnormal configurations. This refueling concentration of soluble boron provides about a 30% reduction in reactivity over the unborated situation and more than adequately suppresses reactivity effects from the above accident situations.

The fuel pool and storage racks are designed so that normal loads, when combined with the forces resulting from the SSE, will not result in failure. The spent fuel pool, fuel transfer canal and cask loading pit are designed to meet the requirements of ACI 318-71. Seismic design considerations of these areas are discussed in detail in Section 3.7 and Subsection 3.8.4.

The spent fuel pool cooling pump intake nozzle is located approximately two feet below the water level elevation, and the return line terminates approximately 11 feet above the top of the spent fuel assemblies. The failure of piping external to these penetrations will not result in lowering of the pool water below this elevation. The amount of water remaining above the top of the fuel assemblies is approximately 15 feet, and this will result in a pool surface radiation level of less than 2.5 mr/hr.

The cask loading pool and the spent fuel pool are separate pools. The isolation gate between the pools is typically closed. During cask handling operations (spent fuel shipping cask, dry fuel storage system transfer cask, dry shielded canister) the single-failure-proof cask handling crane is used to lift and transport heavy loads over the cask loading pool. As a load drop is of such low probability as to not be considered a credible event, and a loss of spent fuel pool water need not be postulated, the gate may be left open during cask handling operations. See Figure 1.2-17 for the limits of travel for the cask handling crane. The crane cannot pass over the spent fuel storage area; hence the transfer cask cannot be transported over this area. The cask travels over the cask handling dry storage area as it travels from the receiving area to the cask loading pool. The spent fuel cask cannot travel over any safety-related equipment other than Alternate Spent Fuel Pool Cooling System (ASFPC) components. The ASFPC system is safety-related. Safe load path drawings administratively prohibit the travel of the single-failure-proof cask handling crane loads over the ASFPC components when the system is in service. Cask handling crane loads over the ASFPC components are allowed only when the system is not in service.

The spent fuel pool liner is designed to preclude the following conditions from occurring:

1. significant release of radioactivity due to mechanical damage to the fuel
2. significant loss of water which could uncover the fuel and lead to the release of radioactivity due to heatup, and
3. loss of ability to cool the fuel, caused by a liner plate falling on top of the fuel racks and blocking the flow of water.

The liner essentially acts as a membrane between the fuel racks and the fuel pool concrete walls, and has been designed for thermal loads. During an SSE condition, hydrostatic forces will be transmitted to the concrete walls through the liner plate (liner plate always being in compression). Concrete walls to which these hydrostatic loads are transmitted, and to which also the equipment embedments are attached, are designed as seismic Category I. Embedments are also designed as seismic Category I. Since the liner will not experience any load other than compression during an SSE, liner plate will not fail, thus precluding conditions 1 through 3 from happening. Fuel racks are designed free standing such that no anchoring to the liner is required and the only load imposed on the liner is a compressive load.

Protection against the effects of tornado and wind loadings is discussed in Section 3.3. Protection against the dynamic effects associated with postulated pipe ruptures is discussed in Section 3.6. Radiation monitoring is discussed in Section 12.3.

9.1.3 Spent Fuel Pool Cooling and Cleanup System

9.1.3.1 Design Bases

The functions of the Spent Fuel Pool Cooling and Cleanup System are to:

a. Continuously remove decay heat generated by fuel elements stored in the pool,

b. Continuously maintain a minimum of 13 feet of water over the spent fuel elements to shield personnel, and

c. Maintain the chemical parameters and optical clarity of the spent fuel pool water, and the water in the reactor cavity and refueling canal during refueling operations.

All portions of the spent fuel pool cooling loop are designated Safety Class 3, and are designed and constructed to meet seismic Category I requirements. Those portions of the cleanup system not designed to these requirements are normally isolated from the cooling loop.

A leak detection system is provided (refer to Subsection 9.1.2.2).

All safety-related portions of the Spent Fuel Pool Cooling System are housed in structures capable of withstanding seismic and flood conditions, as well as tornado-generated missiles. Refer to Section 3.5 for a discussion of internally generated missiles and jet impingement. Protection against dynamic effects associated with postulated pipe ruptures is discussed in Section 3.6.

A seismic Category I normal makeup and a backup supply capable of being connected to an alternate seismic Category I source are provided.

The Spent Fuel Pool Cooling System is designed to assure adequate cooling to stored fuel, assuming a single failure of an active component coincident with a loss of offsite power.

The spent fuel pool cooling and cleanup system design temperature is 200°F, with a design pressure of 150 psig.

A full core offload is routinely performed as part of normal refueling operations. Refuelings are scheduled approximately every 18 months. A full core offload during refueling outages minimizes fuel movement during replacement of the discharged fuel assemblies.

With normal cooling systems in operation coincident with a single active failure, SFP heat exchanger performance evaluations have demonstrated that the full core offload can begin as early as 80 hours after reactor shutdown and the maximum SFP water temperature will remain below 140ºF, as long as the heat load in the SFP does not exceed 46.44×10^6 Btu/hr.

The Spent Fuel Pool (SFP) heat loads were calculated using the Branch Technical Position ASB 9-2 methodology including uncertainties as prescribed in Standard Review Plan Section 9.1.3. The following assumptions were used in the calculation of decay heat.

1. The reactor core heat ouput is 3659 MWth.
2. The operating cycle length is 18 months. Full power operation is assumed for the entire period between refuelings.
3. The decay heat in the SFP is maximized by assuming the SFP is filled to the current licensed capacity (1236 assemblies) upon completion of a full core offload during a normal refueling outage. The decay heat load was calculated assuming the actual discharge history through the end of Cycle 8, plus an assumed discharge of either 80 or 84 assemblies at the end of Cycles 9 through 13, plus a full core offload at the end of Cycle 14. Cycles 9 and 10 assumed a reactor core heat output of 3411 MWth and Cycles 11 through 14 assumed a reactor core heat output of 3659 MWth.
4. The full reactor core offload is a normal refueling condition at Seabrook and is considered in all decay heat calculations.

Using these assumptions, the heat load in the SFP will be equivalent to the design basis heat load of 46.44×10^6 Btu/hr when the full core discharge that results in the spent fuel pool being filled to capacity is complete at approximately 133.8 hours after shutdown.

A steady-state calculation of the heat exchanger performance was used to determine the maximum spent fuel pool temperature for several normal and abnormal refueling conditions. The calculation of the normal cooling capability of the SFP Cooling System assumes the following:

1. Two SFP cooling heat exchangers in service. Primary component cooling water (PCCW) flow is 3000 gpm to each heat exchanger.
2. Two of the three SFP cooling pumps are in service. SFP cooling flow is 1100 gpm for each pump.
3. The Atlantic Ocean is in service or is capable of being placed in service to function as the ultimate heat sink.

A third SFP cooling pump, 1-SF-P10C, has been added to the original design to provide additional cooling capability for the heat load associated with a full core offload during refuelings. The third pump can be powered from either the A or B emergency buses. Electrical power is manually connected to 1-SF-P10C. Manual electrical connection assures adequate electrical separation of the emergency electrical buses.

The SFP Cooling System is designed to cool an SFP heat load of 46.44×10^6 Btu/hr and maintain an SFP temperature less than or equal to 140ºF. This is referred to as the design basis heat load, and is equivalent to the calculated heat load in the SFP assuming the SFP is filled to capacity including a full core offload beginning at 80 hours after shutdown with complete core offload at 133.8 hours after shutdown, under normal cooling conditions.

The normal maximum heat load during power operation (e.g., after completion of the reload) has been calculated as 16.22×10^6 Btu/hr, which corresponds to the decay heat load from 88 freshly discharged assemblies at 30 days after shutdown in addition to the residual heat load from the spent assemblies stored in the full spent fuel pool. The SFP water temperature for the maximum normal heat load during power operation conditions is 119ºF, under normal cooling conditions. If the outage duration is less than 30 days, adequate cooling capability exists to maintain the SFP temperature less than 140ºF.

As described in the Standard Review Plan Section 9.1.3, for the abnormal maximum heat load and/or cooling system alignment, the temperature of the pool water should be kept below boiling and the liquid level maintained with normal systems in operation. A single active failure is not required in the evaluation of the abnormal case. Since Seabrook performs a full core offload as a normal condition during refueling, the limiting abnormal case is defined by the abnormal cooling configuration described below.

A blockage of the Circulating Water tunnels requiring a switchover to the Cooling Tower as the ultimate heat sink is defined as the limiting abnormal cooling configuration. An evaluation of the steady-state performance of the heat exchanger for this case shows that for a full core offload beginning at 80 hours after shutdown with complete core offload at 110 hours after shutdown, the maximum SFP water temperature is calculated to be 159.1ºF for an SFP heat load equivalent to 50.07×10^6 Btu/hr. The thermal hydraulic evaluation of this case demonstrates that there will be no boiling anywhere in the SFP under these conditions. This case considered only one train of Service Water was in service with the PCCW system cross-connected. Two SFP heat exchangers are assumed to be in service with two of the three SFP cooling pumps in operation.

The abnormal case described in Standard Review Plan (SRP) 9.1.3 was also evaluated. The heat load for this case consists of the decay heat from a full core offload at 150 hours after shutdown, plus one refueling load at equilibrium conditions after 36 days decay, plus one additional refueling batch at 400 days decay. Since Seabrook performs a full core offload at each refueling, this case is considered as part of the normal SFP heat load evaluations, and is subject to the acceptance criteria of a maximum SFP temperature of 140ºF. The heat load was calculated using the Branch Technical Position ASB 9-2 methodology including the uncertainties specified in the SRP. The conditions of this scenario are bounded by the assumptions made for calculating the design basis heat load. The decay heat load calculated for the SRP scenario is less than the calculated design basis heat load. Therefore, the maximum SFP temperature for the SRP scenario will remain at less than 140ºF calculated for the design basis heat load.

Table 9.1-3 summarizes the thermal design conditions for the Seabrook SFP.

Provisions have been made to remove decay heat from the stored spent fuel utilizing the alternate spent fuel pool cooling (ASFPC) heat exchanger. Reserved for periods when the reactor is defueled, and primary component cooling water (PCCW) would otherwise not be required, the ASFPC heat exchanger is supplied cooling water from the seismic Category I, Safety Class 3 Service Water System. A temporary nonnuclear safety cooling water source can also be used in conjunction with ASFPC.

Use of the ASFPC System is administratively controlled to limit the heat duty placed on the system while maintaining pool temperature at or below 140°F, based on ASFPC heat exchanger performance.

System component design data, together with the safety and code class requirements, are presented in Table 9.1-1.

Before each refueling outage, FPLE Seabrook will evaluate the performance of the Spent Fuel Pool Cooling System to remove the decay heat load associated with the previously discharged fuel assembly and the full core offload. The evaluation will ensure that the SFP temperature will remain below 140ºF during the full core offload.

9.1.3.2 System Description

The flow diagrams for this system are shown in Figure 9.1-1 and Figure 9.1-2.

The Spent Fuel Pool Cooling and Cleanup System is comprised of three sub-systems:

Spent fuel pool cooling subsystem

Spent fuel pool cleanup subsystem

Reactor cavity and canal cleanup subsystem.

The overall system is comprised of the following major components:

Three spent fuel pool cooling pumps

Two spent fuel pool cooling heat exchangers

One alternate spent fuel pool cooling heat exchanger

One inlet strainer

One pre-filter

One demineralizer

One post filter

One skimmer pump

Five spent fuel pool skimmer intakes

One reactor cavity cleanup pump.

a. Spent Fuel Pool Cooling Subsystem

The spent fuel cooling pumps take suction from the pool and circulate water through the heat exchangers which are cooled by the Primary Component Cooling Water System. An alternate spent fuel pool heat exchanger which is cooled by the Service Water System can be used when the reactor is defueled and PCCW would otherwise not be required. Pool water enters the suction line through a strainer near one wall of the pool at a point thirteen feet higher than the return line terminations. The return lines are located at a sufficient distance from the suction line to assure adequate circulation and uniform pool water temperatures.

All system connections to the fuel pool penetrate at elevations sufficiently above the top of the fuel to maintain adequate shielding in the event the water level drains to the penetration level. Piping arrangement precludes syphoning below this level.

All components in contact with the spent fuel cooling water are stainless steel.

The spent fuel pool pump motors are Class 1E motors. SF-P-10A and SF-P-10B are powered from separate emergency busses. SF-P10C can be aligned to be powered from either emergency bus.

b. Spent Fuel Pool Cleanup Subsystem

Spent fuel pool water quality is maintained by a pool skimmer loop which filters and demineralizes the circulated water. The pool skimmer loop consists of five pool surface skimmers, a skimmer pump, two filters and a demineralizer. This system is utilized to maintain the pool surface free from floating particles and other materials and to remove radioactive materials in the water. The system is sized to process approximately 120 gpm, which means that one-half of the pool volume is processed in a day. All spent fuel pool cooling and cleanup system equipment is located in the Fuel Storage Building, except the filters and demineralizer which are located in the demineralizer area of the Primary Auxiliary Building.

The skimmer pump motor is not Class 1E, and is supplied from a local control center.

The spent fuel pool water quality requirements are referenced in the most recent revision to the EPRI PWR Primary Water Chemistry Guidelines. The EPRI reference is utilized to ensure current industry monitoring practices are maintained. Spent fuel pool purification performance will be monitored by isotopic decontamination factors and ionic impurity removal. Resin replacement will be typically based on these factors and on differential pressure.

Procedures for the station chemistry program are available. The sampling schedule is provided in the station chemistry program manual, which follows the EPRI PWR primary water chemistry guidelines.

Purification is achieved by a dedicated demineralizer containing mixed bed resin. Filtering is achieved with a post-ion exchange filter. A pre-ion exchanger filter is installed and is available as needed. Purification performance is monitored by observing water chemistry and by isotopic analysis across the demineralizer.

The EPRI Guidelines requirements on water chemistry are implemented in the Chemistry Manual and are compatible with the following materials used in the spent fuel racks:

Rack Assembly:	Cans: A-240 Type 304 Grids: A-240 Type 304 Foot Assembly: 17-4 PH SS, A564 Gr 630 - 304L SS, A193 SS
Liner:	Stainless Steel
Poisons:	BORAFLEX (Region 2) - a borated composition comprised of a polymeric silicone encapsulant entraining and fixing fine particles of boron carbide in a homogeneous, stable matrix. The boron carbide powder meets all the requirements of ASTM C-750-74 nuclear grade II material. BORAL (Region 1) - a composite plate material having exterior faces of aluminum alloy 1100 and a core composed of 1100 equivalent aluminum and boron carbide. The boron carbide material conforms to ASTM standard C750 Type 3. See AAR Advanced Structures General Information Bulletin - 0.1 for additional information.

During operation of the alternate spent fuel pool cooling heat exchanger, administrative limits, given below, are placed on spent fuel pool water activity concentrations.

SFP Water Activity Concentration Limit For ASFPC
(μCi/ml)

D.E. I-131	4.2E-3
Cs-137	1.2E-2
Cs-134	2.3E-3
Te-132	3.4E-5
H-3	1.0E+0

c. Reactor Cavity and Canal Cleanup System

The reactor cavity cleanup portion of the system is designed to purify the reactor cavity during refueling operations to improve the optical clarity of the water. A composite drawing showing this function is shown in Figure 9.1-2, sh.3. The system consists of five surface skimmers at the water surface of the refueling cavity and canal and three drains, all piped to the suction of the reactor cavity cleanup skimmer pump via a lead-shielded disposable cartridge type filter unit. The lead-shielded filter removes radioactive particulate in the refueling water in order to prevent CRUD buildup in socket welded piping downstream of the skimmer pump. This filter also minimizes CRUD buildup in the CVCS and SF Cleanup System filters and demineralizers depending on the particular lineup. The cavity water is pumped through the chemical and volume control system mixed bed demineralizer and filters to the suction of the residual heat removal pumps where it is returned to a cold leg through a residual heat removal heat exchanger.

During cavity draindown upon completion of refueling, refueling water can be routed via the Reactor Cavity Cleanup System to the RWST via the Spent Fuel Cleanup System. Also, the Reactor Cavity Cleanup System may be used to send refueling water to the Liquid Waste System floor drain tanks. This lineup would be primarily utilized at the conclusion of draindown when the residual refueling water may not be suitable for return to the RWST.

As an alternative to utilizing the installed cavity cleanup pump and shielded filter, a provision exists to install temporary equipment between isolation valves SF-V81 and 85.

The reactor cavity cleanup pump motor is not Class 1E, and is supplied from a motor control center in the Control Building.

9.1.3.3 Safety Evaluation

Normally, more than 25 feet of water is maintained over the spent fuel. During fuel handling operations, the operator is protected from direct shine emanating from the spent fuel by at least 10 feet of water. The purification provided by the cleanup system, in addition to the water levels maintained above the spent fuel, result in a pool surface radiation level of less than 2.5 mr/hr, which allows unlimited operator access to the surface of the pool and cooling system components. However, the filters and the demineralizer in the cleanup system are expected to collect particulate and ionic radioactive materials, and thus have restrictive access. These components are located in the Primary Auxiliary Building behind shield walls.

To maintain pool water temperature below 140°F at the design basis heat load for maximum normal operating conditions, both SFP heat exchangers are required to be operable, with flow from two SFP cooling pumps. There are three SFP cooling pumps and each pump is capable of circulating water through either spent fuel pool heat exchanger. If one pump becomes inoperable for any reason, the remaining pumps can supply flow to each heat exchanger, maintaining pool water temperature below 140°F.

The Spent Fuel Pool Cooling and Cleanup System is designed so that the pool level will not be inadvertently drained below a point approximately 15 feet above the top of the spent fuel assemblies. The spent fuel pool suction line penetration and the return line terminations are located at elevations such that the failure of piping external of these penetrations will not result in lowering the pool water level below this elevation.

Each spent fuel pool heat exchanger is normally supplied cooling water from a separate primary component cooling water loop (see Subsection 9.2.2). During plant shutdowns when two trains of RHR are not required to be operable in accordance with the Technical Specifications the PCCW loops may be cross-connected so that one PCCW train supplies both SFP heat exchangers. In the unlikely event that all forced circulation cooling flow to the pool is lost, the large volume pool water (approximately 280,000 gallons) provides a heat sink which allows time for maintenance. PCCW cooling to the SFP heat exchangers is automatically isolated in response to a "T" signal. Manual operator action is required to restore PCCW flow to the SFP heat exchangers. The minimum time for the entire pool water volume to reach the saturation temperature from 140°F is 9.7 hours for the 16 spent core region storage condition. For a full core offload beginning at 80 hours after shutdown, proceeding at a discharge rate of six assemblies per hour, with the core offload complete at 110 hours after shutdown, the decay heat load in the SFP at 110 hours is 50.07×10^6 Btu/hr. With this decay heat load and a complete loss of spent fuel pool cooling, the minimum time for the entire pool water volume to reach the saturation temperature from 140ºF is 3.13 hours.

The alternate SFP heat exchanger is supplied cooling water from the Service Water System (see Subsection 9.2.1). Use of the alternate SFP cooling system will be evaluated on a case-by-case basis, as necessary.

Spent fuel pool makeup water can be obtained from either the refueling water storage tank, Chemical and Volume Control System, demineralized water, or the condensate storage tank, as necessary. The refueling water storage tank and its piping to the pool is seismic Category I. A hose connection is provided in the emergency feedwater pump suction piping from the seismic Category I condensate storage tank. The connection is located in the seismic Category I Emergency Feedwater Pump Building and serves as a backup source of makeup to the pool.

The failure of portions of the system, or of other systems not designed to seismic Category I requirements and located close to essential portions of the cooling loop, will not preclude essential functions.

Interconnections between the Spent Fuel Cooling System and the Chemical and Volume Control System are provided to supply borated water, if necessary. A failure analysis of the Spent Pool Cooling and Cleanup System is presented in Table 9.1-2.

9.1.3.4 Inspection and Testing Requirements

Operation of the system to meet construction and pre-operational cleaning needs satisfies the testing requirements. The active components of the system are in continuous use during normal plant operation. Periodic tests are performed for the spent fuel pool cooling pumps in accordance with station procedures. Routine visual inspection of the system components, instrumentation and trouble alarms provide adequate means to verify system operability. However, when the cooling and cleanup loops are cross-connected through valves SF-V14 and SF-V66 an operator is to be posted at the valves during the complete time the cross-connection exists, to assure that the valves can be closed immediately should circumstances require. Pool level indicators and associated alarms are tested by simulating low water level in the sensors. Preventive maintenance is conducted according to established station procedures.

9.1.3.5 Instrumentation Requirements

The instrumentation requirements for monitoring the Spent Fuel Cooling and Purification System performance are as follows:

a. The level in the spent fuel pool is monitored and level indication is available in the control room. Both high and low levels are annunciated in the control room, while low level is alarmed locally.

b. The pump discharge pressure is monitored for the cooling pumps and the fuel pool skimmer pump. Differential pressures are measured across the filter and demineralizer. Local pressure indications are provided. High differential pressures are annunciated in the control room.

c. Total coolant flow is monitored by a flow meter in the common discharge line from the heat exchangers. Local and control room indication is provided. Low discharge flow is annunciated in the control room.

d. The pool water temperature is monitored at the suction to the cooling pumps and both local readout and control room alarm and indication are available.

e. Motor controls for this system are located in a control panel adjacent to the equipment in the Fuel Storage Building, the associated motor control centers, or at the main control board.

9.1.4 Fuel Handling System

The Fuel Handling System (FHS) consists of equipment and structures used for the refueling operation in a safe manner meeting General Design Criteria 61 and 62 of 10 CFR 50, Appendix A.

9.1.4.1 Design Bases

a. The primary design requirement of the equipment is reliability. A conservative design approach is used for all load-bearing parts. Where possible, components are used that have a proven record of reliable service. Throughout the design of equipment in containment, consideration is given to the fact that the equipment will spend long idle periods stored in an atmosphere of 120°F and high humidity.

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

c. Handling equipment used to raise and lower spent fuel has a limited maximum lift height so that the minimum required depth of water shielding is maintained.

d. The Fuel Transfer System (FTS), where it penetrates the containment, has provisions to preserve the integrity of the containment pressure boundary.

e. Criticality during fuel handling operations is prevented by geometrically safe configuration of the fuel handling equipment.

f. Handling equipment will not fail in such a manner as to damage seismic Category I equipment or spent fuel in the event of a Safe Shutdown Earthquake.

g. Except as specified otherwise in this document, the crane structures are designed and fabricated in accordance with CMAA Specification No. 70 for Class A-1 service.

h. The static design load for the refueling machine crane structure and all its lifting components is normal, dead and live loads, plus three times the fuel assembly weight with a Rod Cluster Control Assembly.

i. The original design allowable stresses for the refueling machine structures and components supporting a fuel assembly are as specified in the ASME Code, Section III, Subarticle XVII-2200. Allowable stress criteria for rated loads for the spent fuel pool bridge and hoist, cask handling crane, and polar gantry crane are in accordance with CMAA-70. Modifications to the refueling machine components/structures meet the allowable stress limits per the AISC Manual of Steel Construction, 9th edition (Allowable Stress Design).

j. The design load on wire rope hoisting cables does not exceed 0.20 times the average breaking strength. Two cables are used in the refueling machine and each is assumed to carry one half the load.

k. A single finger on the fuel gripper can support the weight of a fuel assembly and Rod Cluster Control Assembly without exceeding the requirements of Item i. above.

l. All components critical to the operation of the equipment are located so that parts which can fall into the reactor are assembled with the fasteners positively restrained from loosening under vibration.

m. The inertial loads imparted to the fuel assemblies or core components during handling operations are less than the loads which could cause damage.

n. Physical safety features are provided for personnel operating handling equipment.

Industrial codes and standards used in the design of the fuel handling equipment:

a. Applicable sections of CMAA Specifications No. 70.

b. New Fuel Elevator Hoist: Applicable Sections of HMI-100 and ANSI B30.16.

c. Structural: ASME Code, Section III, Appendix XVII, Subarticle XVII-2200 (Refueling Machine).

d. Electrical: Applicable standards and requirements of the National Electrical Code and NFPA No. 70 are used in the design, installation, and manufacturing of all electrical equipment.

e. Materials: Main load-bearing materials conform to the specifications of the ASTM standard.

f. Safety: OSHA Standards 29 CFR 1910, and 20 CFR 1926 including load testing requirements; the requirements of ANSI N18.2, Regulatory Guide 1.29 and General Design Criteria 61 and 62.

Protection of the FHS from wind and tornado effects is discussed in Section 3.3. Flood protection is discussed in Section 3.4. Missile protection is discussed in Section 3.5.

9.1.4.2 System Description

The Fuel Handling System (FHS) consists of the equipment needed for the refueling operation on the reactor core. Basically this equipment is comprised of fuel assembly, core component and reactor component hoisting equipment, handling equipment and a Fuel Transfer System (FTS). The structures associated with the fuel handling equipment are the refueling cavity, the refueling canal in Containment and in the FSB, and the fuel storage area.

The elevation and arrangements drawings of the fuel handling facilities are shown on Figure 1.2-15, Figure 1.2-16, Figure 1.2-17, Figure 1.2-18, Figure 1.2-19, Figure 1.2-20 and Figure 1.2-21.

a. Fuel Handling Description

New fuel assemblies received for core refueling are removed one at a time from the shipping container, lowered into the fuel storage area by the 5-ton hook on the cask handling crane, and stored in the new fuel storage racks.

The fuel handling equipment is designed to handle the spent fuel assemblies underwater from the time they leave the reactor vessel until placed in a container for shipment from the site. Underwater transfer of spent fuel assemblies provides an effective, economic and transparent radiation shield, as well as a reliable cooling medium for removal of decay heat.

The associated fuel handling structures may be generally divided into two areas: 1. The refueling cavity in Containment, and its canal, 2. The spent fuel storage area in the FSB, including the refueling canal and cask handling areas. The canal and cask handling areas are normally full of water and accessible to operating personnel and the fuel transfer system. The refueling cavity and the spent fuel storage area are connected by a fuel transfer tube. This tube is fitted with a quick closure hatch on the cavity end and a valve on the fuel storage area end. The quick closure hatch is in place and the valve kept closed except during refueling to ensure containment integrity. Fuel is carried through the tube on an underwater transfer car. Fuel is moved from the reactor vessel to the Containment refueling canal and into the FSB refueling canal by the refueling machine. A rod cluster control changing fixture is located in the Containment refueling canal for transferring control elements from one fuel assembly to another fuel assembly. The FTS is used to move fuel assemblies between the Containment Building and the Fuel Storage Building.

After a fuel assembly is placed in the fuel container, the lifting arm pivots the fuel container to the horizontal position for passage through the fuel transfer tube. After the transfer car transports the fuel assembly through the transfer tube, the lifting arm at the end of the tube pivots the container to a vertical position so that the assembly can be lifted out of the fuel container.

In the Fuel Storage Building, spent fuel assemblies are moved about by the spent fuel pool bridge and hoist. When lifting spent fuel assemblies, the hoist uses a long-handled tool to assure that sufficient radiation shielding is maintained. A shorter tool and the crane are used to handle new fuel assemblies from storage rack to the new fuel elevator where the assembly is lowered to a depth at which the spent fuel pool bridge and hoist, using the long handled tool, can place the new fuel assemblies into the fuel container of the FTS.

Decay heat, generated by the spent fuel assemblies in the fuel storage area, is removed by the Spent Fuel Pool Cooling System. After a sufficient decay period, the spent fuel assemblies are removed from the fuel racks and loaded into shipping containers for removal from the site.

b. Refueling Procedure

The refueling operation follows a detailed procedure which provides a safe, efficient refueling operation. Prior to initiating refueling operations, the Reactor Coolant System is borated and cooled down to refueling shutdown conditions, as specified in the Technical Specifications. Criticality protection for refueling operations, including a requirement for checks of boron concentration at least every 72 hours, is specified in the Technical Specifications. The following significant points are assured by the refueling procedure:

1. The refueling water and the reactor coolant contains ≥2000 ppm boron. This concentration, together with the negative reactivity of control rods, is sufficient to keep the core approximately 5 percent Δk/k subcritical during the refueling operations. It is also sufficient to maintain the core subcritical in the unlikely event that all of the Rod Cluster Control Assemblies are removed from the core.

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: (a) preparation, (b) reactor disassembly, (c) fuel handling, and (d) reactor assembly. A general description of a typical refueling operation through the four phases is given:

1. Phase I - Preparation

   The reactor is shutdown and cooled to cold shutdown conditions with the final $K_{eff} \leq 0.95$ (all rods in). Following a radiation survey, the containment is entered. The coolant level in the reactor vessel is lowered to a point slightly below the vessel flange. The fuel transfer equipment and refueling machine are checked for proper operation.

2. Phase II - Reactor Disassembly

All cables, piping and tubing are disconnected at the reactor vessel (simplified head) assembly. Insulation and reactor vessel studs are then removed. The quick closure flange is removed from the fuel transfer tube. The refueling cavity is then prepared for flooding by sealing off the reactor cavity, checking the underwater lights, tools and the FTS, and closing the refueling canal drain holes. The reactor vessel head is unseated, raised to an elevation where the CRDS can be verified disengaged from the reactor vessel head and moved to the reactor vessel storage stand. The refueling cavity is then flooded to the required refueling depth water level (see Subsection 9.1.3.3 and 9.1.4.3e). The control rod drive shafts are disconnected and, with the upper internals, are removed from the reactor vessel. The fuel assemblies and rod cluster control units are free from obstructions and the core is ready for refueling.

3. Phase III - Fuel Handling

The refueling sequence is started with the refueling machine. The positions of partially spent assemblies are changed, and new assemblies are added to the core. Two general methods are used to conduct the refueling sequence.

The first method is a complete core off-load. In this method all the fuel assemblies and core components (control rods, burnable poison assemblies, source assemblies and thimble plugs) are removed from the reactor vessel and placed in the spent fuel pool (SFP). The core components are then removed from their existing fuel assemblies and placed in the desired fuel assemblies for the next fuel cycle, or in a storage location. The last step in this process returns the new and partially spent fuel assemblies with their respective core components to the reactor vessel in accordance with the loading plan for the respective fuel cycle.

The second method is a core shuffle in which some fuel assemblies remain in the reactor vessel at all times during the refueling sequence. In this process, some fuel assemblies are removed to the SFP while other assemblies are repositioned within the reactor vessel. At a minimum, all the fuel assemblies scheduled for removal are placed in the SFP and replaced with new fuel assemblies. The partially spent fuel assemblies may either remain in the reactor cavity or be removed to the SFP and returned to the reactor vessel later in the sequence. Core components (excluding control rods) are changed either in the reactor cavity or SFP. Control rod shuffling in the reactor vessel is prohibited. As with the core off-load process, the final position of all fuel assemblies and core components is in accordance with the loading plan for the respective fuel cycle.

With either method of conducting the refueling sequence, the fuel handling equipment is used in the same manner. Fuel assemblies are withdrawn or inserted into the reactor vessel using the refueling machine. Transfer of assemblies between the Containment Building and Fuel Storage Building is conducted using the Fuel Transfer System. Handling of fuel assemblies in the spent fuel pool is accomplished using the spent fuel pool bridge crane and spent fuel assembly handling tool. Transfer of core components from one fuel assembly to another is accomplished using any one of the various tools available either in the Containment Building or in the Fuel Storage Building. A description of the fuel handling equipment is presented in Subsection 9.1.4.2.c.

High pressure sodium vapor lamps (containing a mercury-sodium amalgam) which have a double, water impermeable barrier, may be used in containment and the FSB during refueling outages, or if SFP fuel movement/inspection is needed during the fuel cycle. These high intensity lamps provide improved lighting with negligible possibility of contaminants reaching reactor water or components, when used in a temporary capacity as described here.

4. Phase IV - Reactor Assembly

Reactor assembly, following refueling, is essentially achieved by reversing the operations given in Phase II - Reactor Disassembly.

During reassembly of the reactor vessel the reactor cavity is rinsed as necessary, then the water in the cavity is drained down, with the water level in the reactor vessel being set at 28 to 32 inches below the reactor vessel flange. The vessel head is then raised from the storage stand and lowered until the guide studs are engaged, and proper insertion of the drive rod shafts into their proper locations in the vessel head is visually confirmed. The head is then seated on to the vessel flange.

c. <u>Component Description</u>

1. <u>Refueling Machine</u>

The refueling machine (Figure 9.1-3) is a rectilinear bridge and trolley system with a vertical mast extending down into the refueling water. 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 the 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. All controls for the refueling machine are mounted on a console in the trolley. The mast is equipped with hardware for in mast sipping tests of fuel assemblies.

The bridge and trolley are positioned on a coordinate system programmed internal to the RFM controls. The coordinate system is based on feedback by absolute encoders. The drives for the bridge, trolley, and hoist are variable speed from 0 feet per minute (fpm) to maximum speed allowed for each axis. The maximum speed for the bridge is 60 fpm. The maximum speed for trolley is approximately 40 fpm, but may be slightly increased to allow smoother operation in a Semi-automatic or Automatic mode. The maximum speed for the hoist is 40 fpm. The auxiliary monorail hoist on the refueling machine has a two-step magnetic controller to give hoisting speeds of approximately 7 to 22 fpm.

Electronic interlocks and limit switches on the refueling machine prevent damage to the fuel assemblies. The winch is also provided with limit switches and an encoder to prevent a fuel assembly from being raised above a safe shielding depth. In an emergency, the bridge, the trolley and the winch can be operated manually using a hand-wheel on the motor shaft. The refueling machine is designed to permit the handling of thimble plugs using a tool supported from the auxiliary hoist.

2. Spent Fuel Pool Bridge and Hoist

The spent fuel pool bridge and hoist (Figure 1.2-16, Figure 1.2-18 and Figure 1.2-21) is a wheel-mounted walkway, spanning the fuel storage area, which carries an electric monorail hoist on an overhead structure. The spent fuel pool bridge and hoist is used primarily to handle fuel assemblies and associated core components within the fuel storage area by means of long handled tools suspended from the hoist. The hoist travel and tool length are designed to limit the maximum lift of a fuel assembly or core component to a safe shielding depth. The spent fuel pool bridge and hoist is also used to handle irradiated debris containers and to support fuel-related maintenance and inspection activities within the fuel storage area.

All material handled with the spent fuel pool bridge and hoist within the spent fuel pool is administratively controlled to ensure that the consequences of an accidental drop will not exceed the bounds of the most limiting case accident as described in Chapter 15. In addition to the administrative controls a 2100 pound load limit cutout in the hoist programming (normal mode) prevents the crane from moving loads in excess of 2100 pounds over stored fuel. The bridge and hoist are positioned on a coordinate system programmed internally to the SFP Bridge Crane controls. The coordinate system is based on feedback by absolute encoders. The drives for the bridge and hoist are infinitely variable speed from 0 fpm to the maximum speed allowed for each axis. The maximum speed for the bridge, trolley, and hoist are 40 fpm, 40 fpm, and 24 fpm respectively. When approaching their respective zone boundaries, the bridge, trolley, and hoist will gradually decelerate to slow speed. The slow speeds are as follows: the bridge and trolley are 5 fpm and the hoist is 3 fpm. Anytime the crane is operated with its interlocks manually overridden, bridge, trolley, and hoist speeds are limited to 10 fpm, each.

Electronic interlocks and limit switches on the SFP Bridge and Hoist prevent damage to the fuel assemblies. The hoist is also provided with limit switches and dual encoders to prevent a fuel assembly from being raised above a safe shielding depth. In an emergency, the bridge, the hoist trolley and the hoist can be operated manually using a hand-wheel on the motor shaft.

A push-button pendant is provided for controlling bridge, trolley, and hoist motions. All push-buttons are of the momentary contact type. Release of the push-button automatically stops motion and sets the brakes. Electrical interlocks are provided to prevent damage to the fuel assemblies (see Subsection 9.1.4.3).

3. Cask Handling Crane

The cask handling crane (Figure 1.2-17, Figure 1.2-18 and Figure 1.2-20) is an electric overhead traveling crane with a main hook rated capacity of 125 tons and two 5-ton auxiliary hoists. The American Crane Company (ACECO) supplied trolley is single failure proof per the requirements of NUREG-0554. The design of the trolley also conforms to the requirements of CMAA #70-2000 and ASME NOG-1. The Whiting Corporation supplied bridge, which spans the new fuel storage area and the cask handling and decontamination areas, has been evaluated and meets the requirements of NUREG-0544 for single failure proof handling operation. The crane serves the following functions:

- Upending new fuel containers and transferring new fuel to dry storage
- Transferring new fuel from dry storage to the new fuel elevator (auxiliary hook)
- Transferring spent fuel shipping casks in and out of the cask loading and decontamination areas.
- Upending the dry fuel storage system transfer cask and loading the dry shielded canister into the transfer cask.
- Transferring the transfer cask in and out of the cask loading and decontamination areas.
- Miscellaneous lifts to support fuel transfer.

The drives for the bridge, trolleys, and hoists are variable speed. Controls for all motions are variable frequency drive (VFD) providing infinitely variable speeds. All motions can be controlled from either the operator's cab or the radio controller.

4. Polar Gantry Crane

The polar gantry crane (Figure 1.2-5 and Figure 1.2-6) is an overhead gantry crane located in containment with a 103-foot diameter span to the rail centerline. The main hoist has an original design rated capacity of 420 tons and the auxiliary hoist is rated at 53 tons. In response to a notification from the crane supplier and subsequent evaluation, the main hoist has been derated to 302 tons (CMAA#70) and 193 tons (NUREG 0612). The various speeds (fpm) for the crane are as follows:

	Minimum (Full Load)	Maximum (No Load)	
Main Hoist	0.2	3.5	(inching)
Auxiliary Hoist	1.9	30	(inching)
Bridge	40	50	
Trolley	25	30	

The polar crane is used during construction for installation of the reactor vessel and steam generators. It is also used to lift the reactor lower internals as necessary during the life of the plant. The crane is used to remove and replace the reactor head and upper internals during refueling operations.

Magnetic controls provide variable speed for each crane motion. The crane is arranged for cab and floor operation.

5. New Fuel Elevator

The new fuel elevator (Figure 9.1-4 and Figure 9.1-5) consists of a box-shaped elevator assembly with its top end open, and is sized to house one fuel assembly.

The new fuel elevator is normally used to lower a new fuel assembly to the bottom of the FSB refueling canal where it is then transported to the spent fuel storage racks by the spent fuel bridge and hoist. Additionally, the new fuel elevator may be raised or lowered to support inspection and/or repair of new and irradiated fuel assemblies. Controls shall be in place to maintain the safe shielding distance when irradiated fuel is in the elevator. Non-fuel items and equipment may also be transferred using the new fuel elevator. The new fuel elevator hoist rated capacity is 3000 lbs. with a lifting speed of 21 fpm. The hoist is provided with integral motor brake and load brake and gear type limit switch with upper and lower limits. All portions of the elevator car which are immersed in water are stainless steel.

6. Fuel Transfer System

The Fuel Transfer System (Figure 9.1-6, sh.1, Figure 9.1-6, sh.2 and Figure 9.1-6, sh.3) includes an underwater, electric-motor-driven, transfer car that runs on tracks extending from the Containment refueling canal through the transfer tube and into the FSB refueling canal. A hydraulically actuated lifting arm is on each end of the transfer tube. The fuel container in the refueling canal receives a fuel assembly in the vertical position from the refueling machine. The fuel assembly is then lowered to a horizontal position for passage through the transfer tube. After passing through the tube, the fuel assembly is raised to a vertical position for removal by a tool suspended from the spent fuel pool bridge and hoist in the FSB refueling canal. The spent fuel pool bridge and hoist then moves to a storage loading position and places the spent fuel assembly in the spent fuel storage racks.

During reactor operation, the transfer car is stored in the FSB refueling canal. The quick closure hatch is engaged closed on the containment refueling canal end of the transfer tube to seal the reactor containment. The terminus of the tube in the FSB is closed by a valve.

7. <u>Rod Cluster Control Changing Fixture</u>

The rod cluster control changing fixture is a tool for changing rod cluster control elements in the reactor (Figure 9.1-7). The major subassemblies which comprise the changing 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 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; the third is made to support a single rod cluster control element. Situated above the carriage and mounted on the refueling canal wall is the guide tube. The guide tube provides for the guidance and proper orientation of the gripper and rod cluster control element as they are being raised and lowered. The gripper is a pneumatically actuated mechanism which engages the rod cluster control element. It has two flexure fingers which can be inserted into the top of the rod cluster control element 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 comprised 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 elevation control of the gripper.

8. Spent Fuel Assembly Handling Tool

The spent fuel assembly handling tool (Figure 9.1-8) is used to handle new and spent fuel assemblies in the fuel storage area. It is a manually actuated tool, suspended from the spent fuel pool bridge and hoist, which uses four cam-actuated latching fingers to grip the underside of the fuel assembly top nozzle.

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 which prevents the fingers from being accidentally unlatched during fuel handling operations.

9. New Fuel Assembly Handling Tool

   The new fuel assembly handling tool (Figure 9.1-9) is used to lift and transfer fuel assemblies from the new fuel shipping containers to dry storage or to the new fuel elevator. It is a manually actuated tool, suspended from the cask handling crane which uses four cam-actuated latching fingers to grip the underside of the fuel assembly top nozzle. The operating handles to actuate the fingers are located on the side of the tool. When the fingers are latched, the safety screw is turned in to prevent the accidental unlatching of the fingers.

10. Reactor Vessel Head Lift Rig (Modified to Suit Simplified Head Assembly)

    The modified reactor vessel head lift rig (Figure 9.1-12) consists of a welded and bolted structural steel frame with suitable rigging to enable the crane operator to lift the head and store it during refueling operations. Extension legs have been added to accommodate the new components on top of the seismic platform that are part of the integrated Simplified Head Assembly (SHA). The SHA incorporates the missile shield, shroud panels, fans, DRPI, CRDM and other cabling. The lift rig is permanently attached to the reactor vessel head. Attached to the head lift rig are the monorail and hoists for the reactor vessel stud tensioners.

11. Reactor Internals Lifting Device

    The reactor internals lifting device (Figure 9.1-10) is a structural frame suspended from the overhead crane. The frame is lowered onto the guide tube support plate of the internals, and is mechanically connected to the support plate by three breech lock-type connectors. Bushings on the frame engage guide studs in the vessel flange to provide guidance during removal and replacement of the internals package.

12. Reactor Vessel Stud Tensioner and Handling System

The Reactor Vessel Stud Handling System is provided with the capability of handling the studs independent of the main polar crane. The studs and stud tensioners are handled by the hoists supported from a monorail on the shroud structure. The stud tensioners (Figure 9.1-11) are employed to secure the head closure joint at every refueling. The stud tensioner is a hydraulically operated device that uses oil as the working liquid. 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. Three tensioners are provided and are applied simultaneously to three studs located 120 degrees apart. A single hydraulic pumping unit operates the tensioners, which are hydraulically connected in series. The studs are tensioned to their operational load in two steps to prevent high stresses in the flange region and unequal loadings in the studs. Relief valves on each tensioner prevent overtensioning of the studs due to excessive pressure.

9.1.4.3 Safety Evaluation

a. Provisions to Ensure Safe Handling

1. Refueling Machine

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

(a) Safety Interlocks

Operations which could endanger the operator or damage the fuel are prohibited by mechanical or fail-safe electrical interlocks, or by redundant electrical interlocks. All other interlocks are intended to provide equipment protection and may be implemented either mechanically or by electrical interlock, not necessarily fail-safe.

Fail-safe electrical design of a control system interlock may be applied according to the following rules:

(1) Fail-safe operation of an electrically operated brake is such that the brake engages on loss of power.

(2) Fail-safe operation of an electrically operated clutch is such that the clutch disengages on loss of power.

(3) Fail-safe operation of a relay is such that the de-energized state of the relay inhibits unsafe operation.

(4) Fail-safe operation of a switch, termination or wire is such that breakage or high resistance of the circuit inhibits unsafe operation. The dominant failure mode of the mechanical operation of a cam-operated limit switch is sticking of the plunger in its depressed position. Therefore, use of the plunger-extended position (on the lower part of the operating cam) to energize a relay is consistent with fail-safe operation.

(5) Fail-safe operation of an electrical comparator or impedance bridge is not defined.

Those parts of a control system interlock required to be fail-safe which are not or cannot be operated in a fail-safe mode as defined in these rules, may be supplemented by a redundant component or components to provide the requisite protection.

(1) When the gripper is loaded, the RFM will not traverse (between the core and the upender, test fixture, or RCC change basket) unless the guide tube (inner mast) is at full up. The RFM can traverse within the core zone with the gripper loaded and not at full up. The traverse speeds will be restricted during this scenario. The RFM can traverse a small distance at an RCC basket location, upender location, or the test fixture location for fine positioning to aid in withdrawing or inserting a fuel bundle, or latching onto the test fixture.

(2) When the gripper is unloaded, the RFM will not traverse (between the core and the upender, test fixture, or RCC change basket) unless the guide tube (inner mast) is protected in the mast. The RFM can traverse within the core zone with the gripper unloaded and not at inside the mast. The traverse speeds will be restricted during this scenario. The RFM can traverse a small distance at an RCC basket location, upender location, or the test fixture location for fine positioning to aid in withdrawing or inserting a fuel bundle, or latching onto the test fixture.

(3) Hoist lower motion is permitted when loaded in the core zone, upender zone, or RCC change basket only. Hoist lower motion is permitted when unloaded in the same areas as hoist loaded, at the load test fixture, and also from "hoist full up" to "gripper inside mast" in any area. Hoist raise is permitted in any area, loaded or unloaded. Typical interlocks (i.e., overloads, underloads and faults) for hoist motion will interrupt these motions at all times.

(4) Traverse of the trolley and bridge is permitted in the areas of Item (3) and a clear path connecting those areas unless in a bypass condition. Traverse of the bridge and trolley is also permitted in the area of the lower internals stand.

(5) The gripper is monitored by limit switches to confirm operation to the fully engaged or fully disengaged position. An audible and a visual alarm is actuated if both engaged and disengaged switches are actuated at the same time or if neither is actuated. A time delay may be used to allow for recycle time of normal operation.

(6) When initially loaded, the fuel gripper must be in its down position in the core, or in the Fuel Transfer System, or RCC change basket, with a slack cable, and the air pressure interlock is not tripped in order to unlatch. At the load test fixture, the weight must be off the gripper to unlatch.

(7) Raising of the guide tube is not permitted if the gripper is unlatched and the load monitor indicates a load above normal gripper weight.

(8) Hoist raise is not permitted if the load exceeds the 150 lb. overload condition per fuel type unless the hoist elevation is in a load bypass zone where the overload is set at +200 lb. In all zones, there is a backup overload set at +250 lb.

(9) Hoist lower is not permitted if the load is less than the -150 lb. setting per fuel type unless the hoist is positioned in a load bypass zone. If it is in this zone, a slack cable and/or encoder value interlock would stop motion.

(10) The guide tube is prevented from rising to a height where there is less than 10 feet of nominal water coverage over the fuel assembly providing the refueling pool level is maintained properly.

(11) The guide tube is prevented from lowering completely out of the mast.

(12) The hoist travels at a slow speed, about 3 fpm, at the "near full up zone," at the "near full down zones," when a loaded gripper is inserting a fuel assembly into the core, and when a loaded gripper is entering the mast. In addition, the hoist has intermediate auto-stop points. One point is when a loaded hoist is ready to insert a fuel assembly in the core. The second point is just above the "full down in core." The third point is when an unloaded gripper is raising and enters the mast so it is protected. All of these intermediate auto-stop points require operator interaction before proceeding.

(13) The Fuel Transfer System upender is prevented from moving unless the loaded gripper is in the full up position or the unloaded gripper is withdrawn into the mast, or unless the refueling machine is out of the fuel transfer zone. An interlock is provided from the refueling machine to the Fuel Transfer System to accomplish this.

(b) Bridge and Trolley Hold-Down Devices

Both the refueling machine bridge and the 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 anti-rotation bars located at each of the four wheels for both the bridge and trolley. The anti-rotation bars are bolted to the trucks and extend under the rail flange. Both horizontal and vertical restraints are adequately designed to withstand the forces and overturning moments resulting from the Safe Shutdown Earthquake.

(c) Main Hoist Breaking System

The main hoist is equipped with two braking systems. A solenoid release-spring set electric brake is mounted on the motor shaft. This brake operates in the normal manner to release upon application of current to the motor, and to set when current is interrupted. The second brake is a mechanically actuated load brake internal to the hoist gear box that 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, this motor cams the brake open; in lowering, the motor slips the brake allowing the load to lower. This brake actuates upon loss of torque from the motor for any reason and is not dependent on any electrical circuits. Both brakes are rated at 125 percent of the hoist design load.

(d) Fuel Assembly Support System

The Main Hoist 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 independent wire ropes are anchored to the winch drum and carried to a load equalizing mechanism on the top of the gripper tube.

The working load of fuel assembly with an RCC inserted plus gripper is approximately 2600 pounds (1,000 lbs. for mast plus 1,600 lbs. for fuel assembly with RCCA). Minimum hoist design load is 133 percent of working load.

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

Prior to removing fuel, during each refueling outage, the Gripper and Hoist System are routinely load tested in accordance with Technical Specifications. The test load is greater than 125 percent of the setting on the hoist backup overload limit [3563 lbs = 125% (2600 + 250 lbs)].

2. Fuel Transfer System

The following safety features are provided in the Fuel Transfer System.

(a) Transfer Car Permissive Switches

The transfer car controls are located in four consoles; two are in the fuel storage building and two are in containment. The system can be controlled from any of the four consoles. The consoles are networked together, and the primary console in the Fuel Storage Building will control the winch to move the carriage. The Spent Fuel Pool Bridge Crane console is the second console in the Fuel Storage Building, and enables operators to control the Fuel Transfer System from the bridge walkway. A local-remote transfer switch is installed on the Fuel Transfer System Control Panel, which determines whether or not remote control from the bridge walkway may be used. On the console in containment, there is a local/remote switch which will give control to the refueling machine for automatic control of the car if all interlock conditions are correct.

Transfer of the car is possible only when both lifting arms are in the down position as indicated by the proximity switches. The switches and the controls in the consoles interlock out movement unless the frames are in the down position. If a switch failure occurs, a second set of contacts in the switch can be used by turning a switch on the control console for the switch. A bypass is also allowed for one operation (if necessary) at a time if both contacts fail. This bypass will reset itself automatically.

(b) Lifting Arm - Transfer Car Position

Two redundant interlocks 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 interlocks which allow lifting arm operation only when the transfer car is at the end of its travel, one interlock is a proximity limit switch in the control circuit. The backup interlock is a mechanical latch device on the lifting arm that is opened by the car moving into position.

(c) Transfer Car - Valve Open

An interlock on the transfer tube valve permits transfer car operation only when the transfer tube valve position switch indicates the valve is fully open. A bypass is available for this interlock.

(d) Transfer Car - Lifting Arm

The transfer car lifting arm 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. The interlock is redundant and can withstand a single failure. The basic interlock is a proximity 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.

(e) Lifting Arm - Refueling Machine

The refueling canal lifting arm is interlocked with the refueling machine. Whenever the transfer car is located in the refueling canal, the lifting arm cannot be operated unless the refueling machine gripper is inside the mast or the refueling machine is not over the lifting arm area.

(f) Lifting Arm - Spent Fuel Pool Bridge and Hoist

The lifting arm is interlocked with the spent fuel pool bridge and hoist. The lifting arm cannot be operated unless the spent fuel pool bridge and hoist is not over the lifting arm area, the spent fuel pool hoist is fully raised, or the fuel handling tool is at unloaded clear.

Isolation gates are provided between the reactor cavity -containment refueling canal and the fuel storage-fuel handling areas in the FSB. In the event that maintenance or repairs are required on the Fuel Transfer System during refueling, the canal can be drained by closing the gates and isolating the reactor cavity and the SFP. This permits continued cooling of the core and the SFP, while repairs are effected on the Fuel Transfer System.

3. Spent Fuel Pool Bridge and Hoist

The spent fuel pool bridge and hoist includes the following safety features:

(a) The spent fuel pool bridge and hoist controls are interlocked to prevent simultaneous operation of bridge drive and hoist or of trolley drive and hoist.

(b) Bridge and trolley drive operations are prevented except when the hoist is in the full up position or unloaded clear position when no fuel is being lifted. The interlock allows up to three inches of bridge or trolley movement at 3 feet per minute when the hoist is not clear.

(c) Low voltage or no voltage for any motion automatically stops the motion and sets the brakes.

(d) A trolley-bridge interlock prevents travel of the bridge from the spent fuel storage area or cask loading area into the interconnecting canal unless the hoist is centered on the canal.

(e1) Dual comparative load cells monitor the hoist load. A 2100 pound load limit cutout in the hoist programming (normal mode) prevents the crane from moving loads in excess of 2100 pounds over stored fuel.

(e2) A second overload protection device is included (bypass mode) on the hoist to limit the uplift force which could be applied to the fuel storage racks. The protection device limits the hoist load when lifting an assembly clear from its seated position to 125 percent (2500 lbs.) of the total weight of a fuel assembly plus control rod and handling tool.

(f) Restraining bars are provided on each truck to prevent the bridge from overturning.

(g) Absolute encoder(s), a geared limit switch, and an ultimate up power limit switch prevent withdrawing a fuel assembly beyond the hoist upper limit.

(h) To assure that the design of the spent fuel bridge and hoist is adequate to withstand the safe shutdown earthquake without loss of structural integrity, the following measures have been implemented:

(1) A seismic analysis has been performed (by the vendor) in accordance with the design control procedures for seismic Category I components for this crane to demonstrate that it will not lose its structural integrity during or subsequent to an OBE or SSE.

(2) Quality control requirements for material processing, welding, and nondestructive examination have been incorporated into the relevant specifications and purchase order documents for this crane to provide a level of confidence in the material and fabrication procedures being used to assure that the intent of Section C2 of Regulatory Guide 1.29 has been met.

(3) The crane vendor is required to provide certificates of compliance for all load carrying members used in the fabrication of the crane.

(4) The welding procedures used to fabricated the crane have been reviewed.

4. New Fuel Elevator

The new fuel elevator includes the following safety features:

(a) The hoist is provided with integral motor brake and load brake and a geared limit switch with upper and lower limits. The switches automatically stop and apply the brake when the elevator reaches a predetermined upper and lower limit.

(b) The new fuel elevator is designed to withstand the safe shutdown earthquake without loss of structural integrity such that its failure cannot adversely affect stored fuel or safety-related seismic Category I equipment.

5. Cask Handling Crane

The cask handling crane includes the following safety features:

(a) Low voltage or no voltage for any motions automatically stops the motion and sets brakes.

(b) Limit switches are provided to stop the hook in its highest and lowest safe positions.

(c) The cask handling crane cannot travel over the spent fuel storage area or safety-related equipment other than Alternate Spent Fuel Pool Cooling System (ASFPC) components, described in Section 9.1.3. The ASFPC system is safety-related. Safe load path drawings administratively prohibit the travel of the cask handling crane loads over the ASFPC components when the system is in service. Cask handling crane loads over the ASFPC components are allowed only when the system is not in service.

(d) To assure that the design of the cask handling crane is adequate to withstand the safe shutdown earthquake without loss of structural integrity, the following measures have been implemented:

(1) A seismic analysis has been performed (by the vendor) in accordance with the design control procedures for seismic Category I components for this crane to demonstrate that it will not lose its structural integrity during or subsequent to an OBE or SSE. The reanalysis performed on the trolley, bridge, and crane runway structures in support of upgrading the Cask Handling Crane to meet the single failure proof requirements of NUREG-0554 utilized the methods specified in NRC Regulatory Guide 1.92, Rev. 1, Positions C.1.1 and C.1.2.3 to combine modal responses.

(2) Quality control requirements for material processing, welding and nondestructive examination have been incorporated into the relevant specifications and purchase order documents for this crane to provide a level of confidence in the material and fabrication procedures being used to assure that the intent of Section C2 of Regulatory Guide 1.29 has been met.

(3) The crane vendor is required to provide certificates of compliance for all load carrying members used in the fabrication of the crane.

(4) The welding procedures used to fabricated the crane have been reviewed.

6. Polar Gantry Crane

The polar gantry crane includes the following safety features:

(a) All enclosed portions of the crane equipment are vented by positive openings to the environment.

(b) Low voltage or no voltage for any motions automatically stop motion and set brakes.

(c) Limit switches are provided to stop the hook in its highest and lowest safe positions.

(d) The polar gantry crane is not a seismic Category I component. However, the crane is designed so that it will not fail in such a manner as to damage safety-related equipment or in any way prevent the performance of its safety function in the event of a safe shutdown earthquake.

7. Fuel Handling Tools and Equipment

All fuel handling tools and equipment handled over an open reactor vessel are designed to prevent inadvertent decoupling from machine hooks (i.e., lifting rigs are pinned to the machine 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:

(a) 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-operated valves are equipped with safety locking rings to prevent inadvertent actuation.

(b) Spent fuel handling tool: When the fingers are latched a pin is inserted into the operating handle which prevents inadvertent actuation. The tool is tested at 125 percent of the weight of one fuel assembly.

(c) New fuel assembly handling tool: When the fingers are latched a safety screw is screwed in preventing inadvertent actuations. The tool weighs approximately 100 pounds and is preoperationally tested at 125 percent of the weight of one fuel assembly (1600 lbs.).

b. Seismic Considerations

1. All Fuel Handling Equipment, Except Spent Fuel Pool Bridge and Hoist, New Fuel Elevator, Cask and Polar Cranes

The safety classifications for all fuel handling and storage equipment are listed in Section 3.2. These safety classes provide criteria for the seismic design of the various components. Class 1 and Class 2 equipment is designed to withstand the forces of the Operating Basis Earthquake (OBE) and Safe Shutdown Earthquake (SSE). For normal conditions plus OBE loadings, the resulting stresses are limited to allowable working stresses as defined in the ASME Code, Section III, Appendix XVII, Subarticle XVII-2200 for normal and upset conditions. For normal conditions plus SSE loadings, the stresses are limited to within the allowable values given by Subarticle XVII-2110 for critical parts of the equipment which are required to maintain the capability of the equipment to perform its loading combination which includes the SSE to the extent that there is no loss of safety function.

The Class 3 fuel handling and storage equipment satisfies the Class 1 and Class 2 criteria given above for the SSE. Consideration is given to the OBE only insofar as failure of the Class 3 equipment might adversely affect Class 1 or Class 2 equipment.

2. Spent Fuel Pool Bridge and Hoist, New Fuel Elevator, Cask and Polar Cranes

Allowable stresses are limited to two-thirds of the ASTM minimum specified yield strength for the Operating Basis Earthquake (OBE) and 90 percent of the ASTM minimum specified yield strength for the Safe Shutdown Earthquake (SSE).

3. All Fuel Handling and Storage Equipment

   For nonnuclear safety equipment, design for the SSE is considered if failure might adversely affect a Safety Class 1, 2 or 3 component. Design for the OBE is considered if failure of the nonnuclear safety component might adversely affect a Safety Class 1 or 2 component.

c. Containment Pressure Boundary Integrity

The fuel transfer tube which connects the refueling canal (inside the reactor containment) and the fuel storage area (outside the containment) is closed on the refueling canal side by a quick closure hatch at all times except during refueling operations. Two seals are located around the periphery of the quick closure hatch with leak-check provisions between them. A valve is provided on the Fuel Storage Building side of the tube which also is closed except during refueling operation.

Expansion joints are utilized on the transfer tube/sleeve assembly to accommodate the difference in displacement between the Containment Building and Fuel Storage Building in a seismic event.

Provisions are made for leak checks at each weld which serves as a pressure boundary for the containment environment and at welds between the transfer tube and refueling canal liner in the Fuel Storage Building.

d. Spent Fuel Handling

The cask loading pool and the spent fuel pool are separate pools. The isolation gate between the pools is typically closed; however, during cask handling operations, the single-failure-proof cask handling crane is used to lift and transport heavy loads over the cask loading pool. Therefore, the gate may be open as a load drop is not considered a credible event and a loss of spent fuel pool water is not postulated. The single-failure-proof cask handling crane cannot pass over the isolation gate or any part of the spent fuel storage area; hence, the spent fuel shipping cask, the dry shielded canister and the dry fuel storage system transfer cask cannot be transported over these areas. (See Figure 1.2-17 for the limits of travel for the cask handling crane.) The cask handling crane limits of travel prevent it from traveling over any safety-related equipment other than Alternate Spent Fuel Pool Cooling System (ASFPC) components, described in Section 9.1.3. The ASFPC system is safety-related. Safe load path drawings administratively prohibit the travel of the cask handling crane loads over the ASFPC components when the system is in service. Cask handling crane loads over the ASFPC components are allowed only when the system is not in service.

e. Radiation Shielding

During all phases of spent fuel transfer, the gamma dose rate at the surface of the water, which is directly attributed to spent fuel, is 2.5 mr/hr or less. This is accomplished by maintaining a minimum of 10 feet of water above the top of the fuel assembly during all handling operations.

The two fuel handling devices used to lift spent fuel assemblies are the refueling machine and the spent fuel pool bridge and hoist. The refueling machine contains positive stops which prevent the top of a fuel assembly from being raised to within a minimum of 10 feet of the normal water level in the refueling cavity. The hoist on the spent fuel pool bridge moves spent fuel assemblies with a long-handled tool. Hoist travel and tool length likewise limit the maximum lift of a fuel assembly to within a minimum of 10 feet of the normal water level in the fuel storage area. Radiation monitoring instrumentation is described in Subsection 12.3.4.

9.1.4.4 Tests and Inspections

During preoperational testing, the fuel handling and transfer equipment will be tested to demonstrate the functional operability, controls, and protective interlocks prior to use for handling fuel assemblies. Prior to fuel handling operations, the equipment will be inspected and tested in accordance with the requirements as outlined in the Technical Requirements Manual. In addition, the following special tests will be performed.

a. Refueling Machine, RCC Change Fixture, and New Elevator

   The acceptance test at the shop site includes the following:

   1. Hoists and cable are load tested to at least 125 percent of the rated load.
   2. The equipment is assembled and checked for proper functional and running operation.

b. Head Lifting Rig and Internals Lifting Rig (see para. j for simplified head assembly modification)

   The acceptance test at the shop site includes the following:

   1. The rigs are load tested at 125 percent of the rated load.
   2. The rigs are assembled to ensure proper component fit up.

c. New Fuel Assembly Handling Tool and Spent Fuel Assembly Handling Tool

The acceptance test at the shop site includes the following:

1. The tools are load tested to 125 percent of the rated load.
2. The tools are assembled and checked for proper functional operation.

d. Fuel Transfer System

The acceptance test at the shop site includes the following:

The system is assembled and checked for proper functional and running operation.

e. Reactor Vessel Stud Tensioner

The acceptance test at the shop site includes the following:

The tensioner is assembled and checked for proper functional and running operation.

f. New Fuel Elevator

The new fuel elevator hoist is tested by the hoist manufacturer in accordance with ANSI B30.16. The new fuel elevator is assembled and checked for proper operation at installation and prior to use during refueling.

g. Spent Fuel Pool Bridge and Hoist

A loaded running test is performed prior to initial use of the crane in accordance with ANSI B30.2.

h. Cask Handling Crane

All hooks are shop tested at 1.5 times design rating. A longitudinal magnetic particle test is performed on the hooks both before and after the load test.

A no-load and loaded running test is performed in the field prior to initial use of the crane in accordance with ANSI B30.2.0.

i. Polar Gantry Crane

The crane bridge end trucks and bridge (without gantry legs) are completely assembled and wired in the shop prior to shipment, and a no-load running test of all motors is conducted.

All hooks are load-tested in the shop to 1.5 times design rating. A longitudinal magnetic particle test and ultrasonic inspection is performed on the hooks both before and after the load test.

A no-load and loaded running test was performed in the field prior to initial crane operation in accordance with ANSI B30.2.0. Also, the polar crane will be retested for the operating phase in accordance with NUREG-0612 requirements, as outlined in the PSNH report "Response to NRC Generic Request for Additional Information Relating to Control of Heavy Loads," dated May 1983, (UE&C Report No. 9763.006-S-N-5).

j. Head Lift Rig with New Lift Extensions (Simplified Head Modification)

The acceptance test at the shop site includes the following: The new extension members and clevis pins will be load tested to 300 percent of the maximum lift load, held for ten (10) minutes and followed up by nondestructive examination on the critical areas of the members.

The new extension members and clevis pin will be interconnected with the existing lift rig at the Seabrook site and proper fitup verified prior to use.

After completion of the modification a 100 percent load test and nondestructive examination per existing Seabrook Station procedures will be performed.

9.1.4.5 Instrumentation Requirements

The control systems for the refueling machine, spent fuel pool bridge and hoist, and Fuel Transfer System are discussed in Subsection 9.1.4.2c (component description). A discussion of additional electrical controls, such as the interlocks and main hoist braking system for the FHS, is found in Subsection 9.1.4.3a (Safe Handling).

9.1.5 Overhead Heavy Load Handling Systems

In response to NUREG-0612, New Hampshire Yankee submitted a final revised report to the NRC titled, "NUREG-0612, Control of Heavy Loads" dated October 31, 1985, (SBN-887). In the report New Hampshire Yankee committed to the principle of NUREG-0612, including an operator training program, periodic inspection and maintenance program for the cranes and identification of safe load paths for those loads that meet the NUREG-0612 criteria for a heavy load, (i.e., 2100 lbs. and greater). UFSAR Section 9.1.4, Fuel Handling System, describes the lifting equipment and structures used for the refueling operation that meet General Design Criteria 61 and 62 of 10 CFR 50, Appendix A and the requirements of NUREG-0612.

In FPLE Seabrook's commitment to NUREG-0612, FPLE Seabrook takes exception to testing requirements of ANSI N14.6-1978, "Special Lifting Devices for Shipping Containers Weighing 10,000 Pounds (4500 kg) or More," as outlined in Section 5.3, "Testing to Verify Continuing Compliance." In particular, Section 5.3.1(2) states in part that "for special lifting devices that have not been used for greater than one year they will have NDE testing performed on major load-carrying welds and critical areas before returning the device to use."

Under this exception, FPLE Seabrook will perform NDE testing on major load-carrying welds and critical areas of the Reactor Vessel Head Lift Rig and the Internals Lift Rig following the completion of their use in the outage prior to each 10 year ISI outage – OR – before the "device" is used during a 10 year ISI outage. If conditions dictate removal of the Lower Internals outside the normal schedule, the Internals Lift Rig shall receive the full inspection including NDE on completion of its use.

In addition to the above, the full visual and NDE tests shall be performed after any event in which the device, or any of its parts, may have been loaded beyond loads for which it was qualified, loaded in a manner inconsistent with the original design intent, and after any damage or distortion is noted.

NRC Bulletin 96-02, "Movement of Heavy Loads Over Spent Fuel, Over Fuel in the Reactor Core, or Over Safety-Related Equipment," required utilities to review regulatory guidelines associated with the control and handling of heavy loads over spent fuel, over fuel in the reactor core, or over safety-related equipment while the unit is at power, (in all modes other than cold shutdown, refueling, and defueled). Administrative controls contained in FPLE Seabrook's Lifting Systems Manual have been established to guide the operator in determining whether a NUREG-0612 type lift exists. Should a NUREG-0612 lift exist that has not been previously evaluated, then a 10 CFR 50.59 or 10 CFR 72.48 will be performed prior to the lift to determine if a license amendment is required.

9.1.6 References

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2. ORNL/NUREG/CSD-2/V2, "NITAWL-S, SCALE System Module for Performing Resonance Shielding and Working Library Production," R. M. Westfall, L. M. Petrie, N. M. Greene and J. L. Lucius, October 1981.
3. ORNL/NUREG/CSD-2/V1/R2, "KENO-Va, An Improved Monte Carlo Criticality Program with Supergrouping," L. M. Petrie and N. F. Landers, December 1984.
4. ORNL/NUREG/CSD-2/V2/R5, "CSAS: Control Module for Enhanced Criticality Safety Analysis Sequences," N. F. Landers and L. M. Petrie, September 1995.
5. ORNL/NUREG/CSD-2/V2/R5, "BONAMI: Resonance Self-shielding by the Bondarenko Method," N. M. Greene, September 1995.
6. ORNL/NUREG/CSD-2/V2/R5, "NITAWL-II: SCALE System Module for Performing Resonance Shielding and Working Library Production," N. M. Greene, L. M. Petrie and R. M. Westfall, September 1995.
7. ORNL/NUREG/CSD-2/R5, "KENO V.a: An Improved Monte Carlo Criticality Program with Supergrouping," L. M. Petrie and N. F. Landers, September 1995.
8. STUDSVIK/NFA-89/3 - Rev 1, "CASMO-3, A Fuel Assembly Burnup Program," M. Edenius and B. Forssen, January 1991.
9. STUDSVIK/SOA-95/16 - Rev 0, "TABLES-3, Library Preparation Code for SIMULATE-3," D. M. Ver Planck, October 16, 1995.
10. STUDSVIK/SOA-95/15 - Rev 0, "SIMULATE-3 Advanced Three Dimensional Two-Group Reactor Analysis Code," A. S. DiGiovine and J. D. Rhodes, III, October 16, 1995.
11. B&W-1484-7, " Critical Experiments Supporting Close Proximity Water Storage of Power Reactor Fuel, "N. M. Baldwin, G. S. Hoovler, R. L. Eng and F. G. Welfare, July 1979.
12. YAEC-1622, "Validation of the YAEC Criticality Safety Methodology," D. G. Napolitano and F. L. Carpenito, January 1988.
13. YAEC-1862, "Validation of the YAEC Criticality Safety Methodology Using Workstations," S. Van Volkinburg and R. C. Paulson, April 1993.

14. YAEC-1950, Criticality Analysis of Seabrook Station's New and Spent Fuel Boral and Boraflex Storage Racks," R. C. Paulson and S. Van Volkinburg, April 1998.

15. General Information Bulletin - 0.1, "BORAL The Proven Neutron Absorber," AAR Advanced Structures.

16. DFS Transfer Cask Stability Calculation, Calc. C-S-1-10127, Rev. 0.

9.2 WATER SYSTEMS

9.2.1 Station Service Water System

9.2.1.1 Design Basis

The function of the station Service Water System is to transfer the heat loads from various sources in both the primary and secondary portions of the plant to the ultimate heat sink. The system has been designed to supply sufficient cooling water to its heat loads under all possible operating conditions. Service water system flows and heat loads are listed in Table 9.2-1. The ultimate heat sink for all operating and accident heat loads is normally the Atlantic Ocean. The station Service Water System, as described in this section, pertains to the normal heat sink. The Service Water System normally uses seawater with design temperatures between 34°F and 65°F. During the summer months, extended hot weather combined with ocean current changes can result in minor ocean temperature excursions above the 65°F design temperature threshold. System analysis has been performed to permit continued plant operation up to a maximum ocean temperature of 68.5°F.

In the unlikely event that seawater flow to the Service Water Pumphouse is restricted (>95 percent blockage) due to seismically induced damage to the circulating water (seawater) intake and discharge tunnels, a mechanical draft evaporative cooling tower is provided to dissipate shutdown and accident heat loads. Subsection 9.2.5 which describes the ultimate heat sink should be consulted for the sources of water to the Service Water System.

Except for the postulated event above, the Service Water System using the Atlantic Ocean heat sink is designed to perform all safety functions during and following all severe natural phenomena.

The Service Water System has sufficient capacity to supply 150 gpm flow to the Fire Protection System during all operating modes except during a LOCA event when flow is not required and is not available from the Service Water System. Fire protection flow may be obtained during normal mode operations when ocean temperatures are near 65°F without reducing plant load by starting one of the standby service water pumps or by utilizing both secondary component cooling heat exchangers in lieu of the one normally on line, or a second service water pump in that train may be started. Following a transfer from ocean cooling modes, the cooling tower complex can furnish the minimum required amount of 18,000 gallons at the required flow rates.

With the reactor defueled, and primary component cooling water otherwise not required, service water can be supplied to the alternate spent fuel pool cooling (ASFPC) heat exchanger for removal of decay heat. The ultimate heat sink cooling tower pumps would normally provide this flow while the Atlantic Ocean serves as a contingent heat sink.

Design feature descriptions are further amplified in the following sections:

Design Feature	Updated FSAR Reference
Protection against the effects of tornado and hurricane winds	3.3
Protection against flooding	3.4
Protection against postulated missiles	3.5
Protection against the dynamic effects associated with postulated pipe ruptures	3.6
Protection against extreme low water levels resulting from storm surges	2.4.11.2/2.4.11.6

Structures containing service water system components that are required for safety functions are seismic Category I. Table 9.2-2 lists safety-related component design data.

A failure analysis of the Service Water System and its components is presented in Table 9.2-3.

9.2.1.2 System Description

The station service water system flow diagram is shown in Figure 9.2-1 and Figure 9.2-2. The system consists of two completely independent and redundant flow trains, each of which supplies cooling water to a primary component cooling water heat exchanger, a diesel generator jacket water cooler, the secondary component cooling water heat exchangers, the auxiliary secondary component cooling water heat exchangers, the condenser water box priming pump seal water heat exchangers the alternate spent fuel pool cooling (ASFPC) heat exchanger, and, except during a LOCA, to the Fire Protection System during a fire.

The ASFPC heat exchanger is placed into service when PCCW is taken out of service and spent fuel pool cooling must be maintained. For ASFPC operation the cooling tower pumps are aligned to supply cooling flow to the diesel jacket coolers and the ASFPC heat exchanger.

Flow in each redundant train is supplied by two redundant service water pumps. Each service water pump is capable of supplying 100 percent of the flow required by each flow train to dissipate plant heat loads during normal full power operation. Thus, for full power operation two pumps per unit (one pump per flow train) will be required.

The four service water pumps take suction from a common bay in the Service Water Pumphouse. Seawater flow is supplied to the Service Water Pumphouse from the Atlantic Ocean due to the static head of the ocean above the elevation of the service water pumps suctions. Water levels above the pump suction exceed pump submergence requirements of 4.5 feet above the lip of the pump bell providing adequate NPSH under all expected operating conditions.

The service water pump pit area is divided in half by a concrete wall which segregates the service water pumps from those of the unfinished former Unit 2. Refer to Figure 9.2-2, sh.1. The pumps are supplied sea water by a line from the circulating water intake transition structure. The line is sized to provide the total flow necessary to meet cooling water requirements (21,000 gpm/line) during normal power operation. The line is therefore capable of providing more than twice the flow necessary for safe shutdown of the unit. In addition, the pumps are supplied sea water by a line from the discharge transition structure, used during tunnel heat treatment operations. For the layout of the Service Water Pumphouse refer to Figure 1.2-46, Figure 1.2-47 and Figure 1.2-48.

A basket-type strainer is provided in each train to prevent shells and mussels, which could be carried into these lines, from fouling any of the heat exchangers except the ASFPC heat exchanger which normally receives flow from the cooling tower. A bypass line around the strainers is also provided to allow continued plant operation in the event the strainers must be isolated for maintenance or cleaning. Biofouling control for the Service Water System is provided by continuous low-level chlorination as depicted in Figure 10.4-5. During tunnel heat treatment procedures, if necessary, the main circulating water piping is aligned such that main circulating water is supplied from the discharge tunnel and the hot condenser discharge water is pumped out the intake tunnel. Depending on operating power levels and prevailing environmental conditions, service water may be supplied from the Service Water Cooling Tower.

Check valves to let air into the system and break vacuum are located at high points and on the cooling tower pump discharges. The service water pumps have continuous vents. The vacuum breaker check valves and service water pump continuous vents minimize pressure transients.

System flow is balanced by orifice plates in the PAB outfall lines, the SCCW heat exchanger outlet lines, the diesel heat exchanger outlet lines, and the cooling tower pump heat exchanger bypass lines. Additional balancing of flow is done by throttling designated valves. The orifice plates are between flanges, so that they can be easily removed when, or if, the orifice hole size needs to be enlarged, which may be necessary as the plant ages. There are no orifice plates in the flow path through the cooling tower, except for the diesels and the heat exchanger bypass lines. Boundary valves between safety class and nonnuclear-safety portions of the system are provided with additional limit switches which directly sense valve shaft position. These switches are provided based on the single failure analyses, which showed that if one of these six boundary valves (V-4, -5, -19, -20, -74, and -76) is the single active failure in the plant, where the valve is still open but indicates closed, an unacceptable volume of water could be lost from the cooling tower basin. The direct indicating limit switches and low cooling tower return flow or dropping basin level will show the operators that a critical boundary valve is still open, and procedures will direct them to shut down the operating cooling tower service water train that is pumping water from the basin. The other cooling tower service water train will remain in service. (The safety class valve is the single failure for this scenario, not a diesel. The valve failure is the most limiting single failure for the Service Water and Cooling Tower System.)

Several of the tunnel transfer valves must remain in a fixed position to eliminate recirculation from the discharge tunnel to the intake tunnel and to facilitate the TA signal generation by assuring overflow pipe drainage, following a postulated tunnel blockage earthquake. To assure the tunnel transfer valves remain in the fixed position during normal and accident operation, they are prevented from repositioning during operation by plant administrative procedures (breaker tagged open, for example) to assure no single active failure could cause repositioning. The valve control circuits are energized only when they must be repositioned for maintenance or tunnel heat treatment.

9.2.1.3 Safety Evaluation

The circulating water (seawater) tunnel supplying the Service Water System is capable of providing the flow necessary during a loss-of-coolant accident. Since cooling flow is provided by the static head of the ocean, the suctions of the service water pumps are located at an elevation below the lowest calculated water levels which would result from the probable maximum hurricane occurring during low astronomical tide (see Subsection 2.4.11.2). This assures that the static head available exceeds service water pump suction requirements, and will always provide the flow rates necessary for the performance of the sink's safety functions. No point in the flow path to the Service Water Pumphouse is higher than this lowest water level. In addition, the offshore intakes are located sufficiently below the extreme low ocean water level to ensure that they will always remain covered. The inlet tunnel is capable of supplying sufficient cooling flow to the Station Pumphouse to satisfy sink safety functions. Piping between the tunnels and the Service Water Pumphouse is separated to assure that a damaged pipe cannot jeopardize the flow path. A relief device (atmospheric overflow) is provided in the service water discharge header from the safety-related equipment in the Primary Auxiliary Building which assures a discharge path should the return line become restricted. The overflow was sized to relieve full flow and is located outside the building so that no safety-related equipment would be flooded by its discharge. All of the lines required for the performance of the sink's safety functions are either buried, have an acceptably low probability of tornado wind/missile induced failure or are housed in concrete structures for protection against all credible missiles or other natural phenomena.

Since each service water pump is capable of supplying each flow train with 100 percent of the flow required, 100 percent backup is provided for the two pumps in operation during normal power operation and more than 100 percent backup under accident conditions.

In the event of a loss-of-coolant accident occurring simultaneously with a loss of offsite power, a single service water pump supplying a single flow train powered from the same emergency bus will provide sufficient capability to dissipate the heat loads. This redundancy ensures that no loss of the cooling function will result should a single failure occur in either flow train.

Each set of two service water pumps supplying each flow train has a dual electrical power supply (offsite or diesel) and is separated from the other train's power supply. A loss of power to the service water pumps supplying one flow train would affect only that flow train. Electrically operated valves are powered by the same power supply train as their associated pumps.

A complete and independent service water system is provided with the exception of the cooling tower basin which is designed for two units. The capability of the Service Water System to perform its safety functions is not influenced by any conditions which may exist in the other unit. The Service Water System has the capability to obtain grab samples for radioactivity analysis, should certain operating conditions (as specified in the Technical Specifications) exist or be exceeded.

The service water pumps and motors are designed to comply with seismic Category I criteria and are housed in a Category I Service Water Pumphouse. Subsections 3.8.4 and 9.2.5 should be consulted for further details on the Service Water Pumphouse. All Safety Class 3 service water system piping and valves are designed in accordance with Section III, Class 3, of the ASME Boiler and Pressure Vessel Code, and comply with seismic Category I requirements.

Cement-lined carbon steel pipe is used throughout most of the Service Water System to prevent long-term corrosion. Elastomeric joint seals have been installed on certain field-welded joints primarily in underground piping. These joint seals consist of an elastomer boot which overlaps the field weld cement liner crevice. The boot is held in place by 6% molybdenum stainless steel retaining bands. These seals have been installed to prevent pitting corrosion of cement-lined carbon-steel piping at field welds due to degradation of original joint compound. Access to piping for joint seal installation and maintenance is via dropout spools installed in the Service Water Pumphouse, PAB, Cooling Tower and service water inspection vault. The diesel generator water jacket heat exchanger lines use plastisol PVC lined carbon steel spooled piping. Inconel 625 is used in a portion of the supply piping to the SCCW heat exchangers. Portions of lines located immediately downstream of throttled valves may be subjected to excessive fluid velocities impinging on fittings, e.g., elbows and tees. In these cases, suitable pipe materials (copper-nickel or piping with molecular-polymer (Belzona Co.) or linings) are used for erosion protection. An epoxy-phenolic (Plasite #7122) coating is used in the cooling tower pipe. The service water side of the primary component cooling water (PCCW) heat exchangers (1-CC-E-17A and 17B) is constructed of titanium for erosion/corrosion protection. Service water pipe which is buried below grade is coated with coal-tar enamel and wrapped with asbestos-felt material. Underground service water piping is cathodically protected. Since service water piping is either drained, buried, housed in buildings or heat-traced, essential service water supply is protected against freezing, icing and other adverse environmental conditions. Protection of the cooling tower and its associated equipment against these conditions is discussed in Subsection 9.2.5.

The service water pump motors are located above flood levels inside a reinforced concrete (seismic Category I) building which provides adequate protection against flooding. Flow from the service water discharge atmospheric vent has essentially an unrestricted path to the open areas which dump into the storm drainage system. As noted in Updated FSAR Subsection 2.4.2.3, all building entrances to areas housing safety-related equipment are at least one foot above grade. Thus, the areas covered by the storm drainage system would have to accumulate more than one foot of water before safety-related areas of the PAB and other structures would be affected.

All safety-related service water piping that conveys ocean cooling water is buried or housed in concrete structures (seismic Category I), has an acceptably low probability of tornado wind/missile induced failure or is otherwise protected to preclude damage from tornado-driven missiles. Portions of buried service water system piping which are nonseismic Category I and which are shown in Figure 9.2-13 are routed in the vicinity of safety-related piping. The nonseismic Category I piping runs in the same general path as the safety-related piping and, therefore, will experience no higher stress levels than the buried safety-related piping in the event of an SSE. In addition, analysis indicates that water jets from a postulated crack in the nonseismic Category I piping would not cause sufficient erosion to compromise the support of adjacent safety-related piping. Since the service water piping is not routed in the vicinity of the large nonseismic Category I circulating water piping, a failure of the latter piping will also not affect the station service water piping.

There are three nonnuclear safety-related station service water lines within the PAB and pipe tunnel adjacent to the PAB, identified as lines 1821-1-LI-24," 1806-3-LI-12" and 1827-3-LI-12" and two lines within the Fuel Storage Building, identified as 1-1845-152-12" and 1-1846-152-12" (see Figure 9.2-2, sh.1, and Figure 9.2-2, sh.2). These lines were analyzed in conjunction with the safety-class portion of these lines. The results of this analysis show that the maximum stresses occurring under seismic conditions are less than the allowable stress levels for Safety Class 3 piping. Accordingly, these lines will not fail as the result of a seismic event.

9.2.1.4 Tests and Inspections

The Service Water System is hydrostatically tested in accordance with ASME Boiler and Pressure Vessel Code Section III, Class 3, except where installation does not permit pressurization. A description of system preoperational testing is contained in Chapter 14.

During plant operation, in-service inspection of the Class 3 portion of the Service Water System is performed in accordance with ASME Code, Section XI.

9.2.1.5 Instrumentation

Control and display instrumentation is provided to permit operation of the Service Water System from the main control room under all normal and abnormal conditions.

Level instrumentation monitors water level in the Service Water Pumphouse. The level is indicated at the main control board in the control room. The computer alerts the operator of low level conditions. The service water pumps are controlled from the main control board as well as the essential switchgear room. The ocean pumps are prevented from operating if either the cooling tower or ocean water pump discharge valve is not fully closed.

The preferred pump placed in the "start" position starts when electrical interlocks are satisfied. The standby pump will start automatically if the preferred pump trips.

After a loss of offsite power, the pump which was running will restart when EPS initial sequence is completed.

The operating pump will trip automatically on a loss of offsite power or "TA" signal. See Subsection 9.2.5 for a discussion of the instrumentation used to generate a tower actuation (TA) signal.

Once the pump starts, its discharge valve will open after a short delay to remove trapped air and will be closed when the pump stops.

Main control room indication associated with each service water flow train includes pump discharge header pressure (see Subsection 9.2.5) and primary component cooling water heat exchanger temperatures.

Diesel generator jacket water heat exchanger discharge valves are controlled from the MCB. The operator can close the valves if the corresponding diesel is not running. A signal from the diesel logic is used to prevent closing the valve when the diesel is in operation.

The secondary component cooling water and condenser water box priming pump seal water heat exchangers are automatically isolated from the Service Water System on a loss of offsite power, tower actuation signal, safety injection signal, or they may be isolated manually from the control room.

The alternate spent fuel pool cooling heat exchanger is placed into service manually. Heat exchanger flow as well as service water inlet and outlet temperatures is indicated locally.

Controls and position indications are provided on the main control board for all motor-operated valves. Control and position indication is also provided on the main control board for each of the fail-open air-operated valves associated with the diesel generators.

9.2.2 Cooling System for Reactor Auxiliaries

9.2.2.1 Design Bases

The Primary Component Cooling Water (PCCW) System supplies flow to the following safeguard components which are required for safe shutdown and/or to ameliorate the consequences of an accident:

a. Containment spray pumps

b. Containment spray heat exchangers

c. Residual heat removal pumps

d. Residual heat removal heat exchangers

e. Safety injection pumps

f. Centrifugal charging pumps

g. Containment enclosure coolers

The system serves as an intermediate fluid barrier between the Reactor Coolant and Service Water Systems assuring that leakage of radioactive fluid from the components being cooled is not released to the environment.

The PCCW system consists of loops A and B which are two independent and redundant flow loops and a reactor coolant pump thermal barrier (RCPTB) loop. Loops A and B are redundant loops, and each supplies component cooling water to one of the redundant components performing engineered safeguard functions to the RCPTB loop, and to other nonsafeguard loads. A supply and return crossconnect and a CC head tank outlet line crossconnect are included in the system design. Each crossconnect consists of two isolation valves. These valves are locked closed when two independent PCCW trains are required to be operable in accordance with plant Technical Specifications.

PCCW loops A and B are designed to perform their safety function while accommodating a single failure of any component coincident with a loss of offsite power.

A passive failure in PCCW loops A or B will not jeopardize flow in the redundant loop. Protection is provided for the primary component cooling water pumps from water jets which might be caused by pipe ruptures in the redundant header. A passive failure in the crossconnect will not jeopardize flow in at least one CC loop.

The RCPTB loop is designed to provide 100 percent of the cooling capacity required to cool the RCPTB cooling coils under all normal plant operating conditions. The RCPTB loop has been classified as nonessential*, but it incorporates special design features to provide a high degree of reliability:

a. PCCW loops A and B each provide cooling to the RCPTB loop.

b. Pipe supports and pressure-retaining system components are designed in accordance with ASME III Safety Class 3 and Seismic Category I requirements.

c. Flow instrumentation trains to the annunciator, pumps, pump drive motors, and associated controls are redundant, are qualified to 1E requirements, and are designed to operate with power from the diesel generators in the event of a loss of offsite power.

d. Instrument sensing lines are designed in accordance with the requirements of ISA Standard 67.02-1980.

Those portions of the PCCW system which furnish cooling water to safeguards components are designated Safety Class 3, seismic Category I, and are located in seismic Category I structures. The crossconnects are designated Safety Class 3, Seismic Category I and are located in Seismic Category I structure.

To provide increased reliability for cooling safety-related components, a crossconnect from the Fire Protection and Demineralized Water systems to the PCCW system is included in the system design. This crossconnect can be used to provide cooling water to the charging pump lube oil coolers or provide emergency makeup water to safety-related portions of the PCCW system. This crossconnect is backed up by a seismic Category I Service Water System and booster pump makeup source.

Protection of the PCCW system from wind and tornado effects is discussed in Section 3.3. Flood protection is discussed in Section 3.4. Missile protection is discussed in Section 3.5. Protection against the dynamic effects associated with postulated rupture in piping is discussed in Section 3.6.

* Except for the rupture discs on the head pipe. These rupture discs perform an essential safety function and are required to be designed and maintained as active, ASME III, Safety Class 3 Valves (see Table 3.9 (B)-27).

9.2.2.2 System Description

a. Description

The flow diagrams for the PCCW system are shown in Figure 9.2-3, Figure 9.2-4, Figure 9.2-5, Figure 9.2-6 and Figure 9.2-13. The PCCW system consists of the RCPTB loop and two independent flow loops, A and B, each of which supplies component cooling water to one of the redundant components performing engineered safeguard functions and to the RCPTB loop and to various nonsafeguard components. One of the two 100 percent (accident conditions) PCCW pumps connected in parallel supplies flow to each loop. One PCCW heat exchanger in loop A and one in loop B transfers the heat loads from the RCPTB loop and plant components to the Service Water System.

A single PCCW loop A or B pump providing flow to the PCCW heat exchanger in its loop is capable of removing the total heat during the recirculation phase following a loss-of-coolant accident occurring simultaneously with a loss of offsite electrical power.

There are four sets of RCPTB cooling coils which are cooled by the single PCCW RCPTB loop located inside the Containment Building. The RCPTB loop cooling water flow from one of two 100 percent capacity pumps flows through two 100 percent capacity series-connected heat exchangers, then flows through the four RCPTB cooling coils that are connected in parallel, then flows through a head/relief pipe and returns to the pump. Valves 3" – CC-V110, V114, V236 and V230 are fully open during RCPTB operation. The two heat exchangers remove heat from the thermal barrier loop; one heat exchanger being cooling by PCCW loop A and the other by PCCW loop B. The supply and return lines from the heat exchangers to loops A and B penetrate the containment wall. One containment isolation valve is placed on each of the four lines. The isolation valves remain open during a LOCA or MSLB event, and are closed manually in the event an abnormality is detected, such as leakage from the penetrations.

The two RCPTB pumps and heat exchangers provide redundancy. One pump is powered from the A train and the other from the B train. The standby pump is arranged to start automatically on low loop flow. In the event the Reactor Coolant Pump Seal Injection System becomes inoperative, and simultaneously loop A or B cooling flow is lost to the respective heat exchanger, the remaining PCCW loop supplying 85°F flow to the RCPTB heat exchanger cools the thermal barrier loop cooling flow to 105°F, as required to thermally protect the reactor coolant pump seals. The pumps and heat exchangers are located outside the missile barrier inside the containment and are designed to function with a loss of offsite power and one train of the diesel generator electric power supplies.

Should it become necessary to transfer to cooling tower operation (see Subsection 9.2.5) during accident conditions, the PCCW loop A or B heat exchangers provide the necessary capacity with 90°F cooling water supplied by the tower. Shortly after the initiation of post-LOCA containment sump recirculation, primary component cooling water supplied to the various components reaches a maximum temperature of approximately 126°F.

Both loops A and B PCCW heat exchangers are required during normal full power operation supplying 85°F cooling water to the components. Only one of the two pumps in each loop is required for normal full power operation.

During normal plant cooldown, both loops A and B PCCW heat exchangers are operated to reduce the reactor coolant temperatures to 125°F within 24 hours after shutdown from full power. If only one loop with one heat exchanger is available, safe shutdown is not affected, but the cooldown time is extended. The PCCW heat exchanger performance is based on 65°F service water circulating through the tube side of the heat exchanger during normal operations. During the summer months, extended hot weather combined with ocean current changes can result in minor ocean temperature excursions above the 65°F design temperature threshold. System analysis has been performed to permit continued plant operation up to a maximum ocean temperature of 68.5°F.

The crossconnects between PCCW Train A and B are administratively controlled. The PCCW crossconnects may be placed in service when two independent PCCW trains are not required to be operable in accordance with the Technical Specifications. Primarily the crossconnects will be placed in service during reactor core off load periods so that one train of PCCW can supply both SFP heat exchangers.

One PCCW system head tank in each of loops A and B accommodates surges due to coolant thermal expansion and contraction and provides sufficient coolant storage to ensure continuous cooling water supply until a leaking cooling line can be isolated. If leakage should occur from nuclear components, the in-leakage to the system is collected in the tanks. The tanks are located at the highest elevation in the system for filling and venting and serve to impose adequate pressure at the PCCW pump suction at all operating temperatures to meet NPSH requirements. Coolant chemistry is controlled by additions of a corrosion inhibitor to the head tanks. Relatively small quantities will be stored in the event that a cooling loop must be drained and refilled. A recirculation line to the tanks from the supply header provides a means of mixing the chemicals. Demineralized water is provided as necessary for makeup water to the system.

The PCCW RCPTB head/relief pipe accommodates coolant thermal expansion and contraction, provides sufficient coolant storage to ensure continuous cooling water supply until a leaking pump seal can be isolated, provides sufficient relief capacity, via rupture discs, to accommodate a RCPTB cooling coil rupture and provides sufficient storage to refill the system following a RCPTB cooling coil rupture. The rupture discs on the head pipe (CC-MM-762 and CC-MM-763) are active. They protect the thermal barrier heat exchangers and ultimately the Code Class 2 piping and tubing that serve as a containment isolation feature. The head pipe located at the highest elevation is the system for filling and venting and provides adequate pressure at the pump to meet NPSH requirements for all operating conditions. Provisions for addition of coolant corrosion inhibitor is included. Also, a recirculation line from the pumps to the head pipe can be used to mix the chemicals. Provisions for demineralized water fill and makeup are also included.

The performance requirements for the PCCW system are summarized in Table 9.2-4, Table 9.2-5 and Table 9.2-6.

Component design parameters are listed in Table 9.2-7.

9.2.2.3 Safety Evaluation

Non-Essential heat loads outside containment are automatically isolated at the PCCW supply and return headers on a "T" signal or on a low head tank level signal. The spent fuel pool heat exchanger is automatically isolated at the PCCW supply header only on a "T" signal. Cooling flow to the Spent Fuel Pool Heat Exchangers is restored manually in accordance with Abnormal Station Procedures. Cooling water flow is supplied to all safeguard components. The Containment Isolation System for PCCW flow to all equipment inside containment, except to the RCPTB HXs, is a two-valve system, and is a single valve system for flow to the RCPTB heat exchangers (see description in Section 6.2). The single valve system on PCCW lines to the RCPTB heat exchanger is designed to limit flow isolation to either loop A or B only, not both simultaneously, in the event a single failure occurs in an electric power train. The second means of containment isolation for the PCCW lines through the RCPTB heat exchangers is provided by the Code Class 2 piping and tubing. Overpressure protection of this containment isolation function is provided by the RCPTB head pipe rupture discs. Flow to the equipment in containment other than the RCPTB is isolated on a "P" signal or on low-low level in the respective head tank. The RCPTB heat exchangers can be manually isolated during a LOCA. Either loop A or B is capable of removing accident heat loads.

a. Arrangements and Reliability

Provisions have been incorporated to preclude flooding of the redundant PCCW pumps. These provisions entail raising the pumps off the floor on pedestals and sloping the floors towards the floor drains which discharge into the floor drain sump. A sump pump discharges this drainage to the floor drain tank of the Liquid Waste Processing System.

All safety class portions of the system are seismic Category I and housed in structures of the same classification. The components are designed to the codes listed in Table 9.2-7. Welded construction (except at component connections where flanged and threaded joints are provided) is used to minimize the possibility of water leakage from piping, valves and equipment.

The component cooling water could become contaminated with radioactive water due to a leak in the heat exchanger tubes in the Chemical and Volume Control, Sampling, or Residual Heat Removal Systems. Therefore, a radiation monitor is supplied in each primary component cooling loop to detect in-leakage from radioactive components. The Radiation Monitoring System is discussed in Section 11.5.

Components which are used during normal plant operations and have a single barrier between primary component cooling water and reactor coolant water are shown in Table 9.2-8. As can be seen from this table, the pressure and temperature design requirements of the barriers in the RHR heat exchangers, the RHR pumps (seal coolers), the letdown heat exchanger, and the seal water heat exchanger are less than the reactor coolant system pressure and temperature during full power operation. In each of these cases, except for the RHR heat exchangers and RHR pumps, this is due to the fact that the pressure and temperature of the reactor coolant are reduced to the values shown in Table 9.2-8 before the flow reaches the components.

In the case of the RHR heat exchangers and RHR pumps (seal coolers), the reactor coolant system pressure and temperature are reduced to approximately 400 psig and 350°F before the Residual Heat Removal System (RHRS) is brought into service to complete the cooldown of the reactor. The RHRS is protected from overpressurization as discussed in Section 7.6. The controls and interlocks provided for the isolation valves between the Reactor Coolant System and the RHRS are also described in Section 7.6.

Leakage of radioactive coolant into the PCCW system could occur from heat exchanger tube leakage in the Chemical and Volume Control, Sampling or Residual Heat Removal Systems. Such leakage would cause a rise in system radioactivity concentration and liquid level, the magnitude of each being proportional to the magnitude of the leak. The PCCW head tank in each loop is vented directly to the Primary Auxiliary Building exhaust fan room. Other flow, temperature, and pressure instrumentation in the components cooled may provide the first indication of and alarm any in-leakage of radioactive fluids into the PCCW system depending on the magnitude of the leak. Continuing rise in the liquid levels of the head tanks would reach a point where a high level alarm would be annunciated in the control room.

Actuation of any of these alarms would initiate an attempt to identify and isolate the leaking component in the loop. If successful, the radioactivity input to the PCCW system would be terminated. If isolation were not accomplished, head tank overflow would be directed to the floor drain tanks which are vented to the Aerated Vent System (see Subsection 9.3.6). The results of the introduction of radioactivity into the PCCW system by radioactive component in-leakage would be that a buffer barrier between the Reactor Coolant and Service Water Systems would be compromised, but that no other consequences would result without further leakage from the PCCW system. With leakage following the radioactivity introduction, the only such leakage that would result in radioactivity release to a system other than the Liquid Waste Processing System would be leakage to the Service Water System through the PCCW heat exchangers.

Leakage from the PCCW system can be detected by a falling level in the PCCW head tanks. The component which is leaking can be located by sequential isolation or inspection of equipment in the loop.

In the unlikely event of a break in the reactor coolant pump thermal barrier cooling coils, the cooling water lines serving the pump thermal barrier are isolated from the rest of the system by check valves located in the supply line and motor-operated isolation valve downstream from the pump. The isolation valve is manually closed on a high flow signal from a flow meter, located upstream of the valve, which is indicative of a rupture in the thermal barrier. The reactor coolant is vented through the head/relief pipe, via the rupture discs, to containment atmosphere until the motor-operated valve can be closed. The design pressure for this portion of the line is the same as the reactor coolant system design pressure assuring that the break is contained in the pipe between the valves. The relief valves on the lines serving the pump are set at the design pressure for the line. The valves are sized to relieve the thermal expansion of the trapped coolant which could occur if the cooling water is isolated while high temperature reactor coolant flows through the thermal barrier, or the hot side of the bearing or air cooler is maintained at temperature.

The relief valves on the cooling water lines downstream from the sample, excess letdown, seal water, letdown, spent fuel pool reactor coolant drain tank and residual heat exchangers, are sized to relieve the volumetric expansion occurring if the exchanger shell side is isolated when cool, and high temperature coolant flows through the tube side. The set pressure equals the design pressure of the shell side of the heat exchangers.

The discharge from relief valves provided on PCCW lines inside the Containment Building drains to the -26' elevation where it drains to the floor drain sump and is pumped to the Liquid Waste Processing System (see Section 11.2).

The maximum expected flow from the relief valves on the lines serving either the reactor coolant pumps or the excess letdown heat exchanger is less than 600 gpm. The maximum flow from the relief valve on the lines from the fan coolers is less than 200 gpm.

The failure of a relief valve (or stuck open relief valve) will not prevent the PCCW system from performing its safety-related functions. If the component causing the relief valve discharge can be isolated, the loop affected can still be used. Should conditions restrict access to the component, or if isolation cannot be affected, the loop (primary component water pump) can be shut down, and the remaining redundant loop is designed to accommodate accident heat loads. During normal operations, the component affected can be isolated and normal operation continued. If, for some reason, the component cannot be isolated and the loop affected must be shut down, the unit must be shut down, since normal operations cannot continue with only one loop. Orderly plant cooldown can be executed with only one primary component cooling water loop; however, the cooldown time is extended.

b. Loss of Primary Component Coolant Incidents

In the unlikely event of a pipe severance in one of the primary component cooling water loops, backup is provided for post-accident heat removal by the redundant loop. Should the break occur outside the containment, the leak could be isolated by valving, and the broken line repaired.

Once the leak is isolated or the break has been repaired, makeup water is supplied from the demineralized water storage tank by the demineralized water transfer pump (see Subsection 9.2.3).

If the break occurs inside containment on a loop A or B cooling water line, the leak can be isolated. Each of the loop A and B supply and return lines serving equipment inside containment contains two automatic isolation valves. One valve is located inside and the other outside the containment. The valves close on presence of a low-low level signal from the head tank in the corresponding loop. The head tank low level signal also closes valves which isolate all nonseismic Category I portions of the system. Thus, the system safety function is not compromised in the event of the failure of the nonseismic Category I portion of the system.

Flow indication is provided on the component cooling water return lines from the centrifugal charging, containment spray, safety injection, and residual heat removal pumps. Each of the PCCW return lines from the residual and containment spray heat exchangers has a remotely operated valve. Cooling water flow is normally aligned to the residual heat removal heat exchanger. The cooling water isolation valve also receives a "T" signal to automatically open the valve to its open position. Cooling water flow to the containment spray heat exchanger is automatically initiated on a "P" signal. If one of the valves fails to open at initiation of long-term recirculation, the other loop has sufficient capacity to remove the heat loads.

c. <u>Electrical Power Supply</u>

The power supply for each of two primary component cooling water pumps and their associated electrically operated valves for each flow train is separated from the other train's power supply. A loss of power to the primary component cooling water pump supplying one flow train would affect only that flow train. One primary component cooling heat exchanger and one primary cooling water pump per loop are required to provide cooling water following a loss of offsite power. Orderly cooldown of the plant may be initiated when proper reactor coolant system temperatures and pressures are established.

Since the PCCW system must perform during an orderly shutdown and supports the engineered safeguards, power supplies, controls and instrumentation to redundant component trains are separated.

d. Failure Analysis

In discussing the potential consequences associated with a loss of PCCW cooling to the reactor coolant pumps (RCP), the cooling concerns can be broken down into two areas: (1) RCP seal cooling and (2) cooling to the RCP motor (bearings and motor windings). Each of these areas will be discussed individually.

1. Reactor Coolant Pump Seal Cooling

The RCP seals are thermally protected by the RCPTB Cooling System and the RCP Seal Water Injection System which are classified as nonessential* for accident conditions. They have been designed to have a high degree of reliability, but they need not be designed to function following a postulated LOCA or MSLB event.

2. Motor Bearing and Winding Cooling

The reactor coolant pump motor bearings are of conventional design. The radial bearings are the segmented pad type, and the thrust bearing is a double-acting Kingsbury type. All are oil-lubricated. Component cooling water is supplied to the external upper bearing oil cooler and to the integral lower bearing oil cooler.

The motor is a water/air cooled, Class B thermalastic epoxy insulated, squirrel cage induction motor. The rotor and stator are of standard construction and are cooled by air. Six resistance temperature detectors are imbedded in the stator windings to sense stator temperature.

The internal parts of the motor are cooled by air. Integral vanes on each end of the rotor draw air in through cooling slots in the motor frame. This air passes through the motor with particular emphasis on the stator end turns. It is then routed to the external water/air heat exchangers, which are supplied with component cooling water. Each motor has two such coolers, mounted diametrically opposed to each other. In passing through the coolers, the air is cooled and then directed back to the motor air inlets through external ducts on the motor so that no air is discharged into the containment from the motors.

A loss of PCCW cooling to the RCP bearing oil and motor cooler will result in an increase in oil temperature and a corresponding rise in motor bearing metal temperature.

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* Except for the RCPTB rupture discs. See Section 9.2.2.2.a for additional information.

In a Westinghouse test program, two RCP motors were tested with interrupted PCCW flow. These tests were conducted at the Westinghouse Electro Mechanical Division. In both cases, the reactor coolant pumps were operated to achieve "hot" (2230 psia, 552°F) equilibrium conditions. After the bearing temperature stabilized, the cooling water flow to the upper and lower motor bearing oil coolers was terminated and bearing (upper thrust, lower thrust, upper guide and lower guide) temperatures were monitored. A bearing metal temperature of 185°F was established as the maximum test temperature. When that temperature was reached, the cooling water flow was restored.

In both tests, the upper thrust bearing exhibited the limiting temperatures, and 185°F was reached in approximately 10 minutes. The average heatup rates experienced in these tests were less than 3.3°F/minute and were basically linear throughout the range of the test. Considering that the melting point of the babbitt-bearing metal is greater than 400°F, it appears likely that considerable time remains, beyond the 10-minute time frame for the bearing temperature to reach 185°F, until bearing damage is incurred.

The results of the test data along with the recommended bearing high temperature alarm setpoint of 185°F and suggested manual RCP trip at 195°F constitute the basis of the qualification for 10 minutes operative without PCCW with no resultant pump damage.

Operating procedures are provided for a loss of component cooling water and seal injection to the reactor coolant pumps and/or motors. Included in these operating procedures is the provision to trip the reactor if component cooling water flow, as indicated by the instrumentation discussed in Subsection 9.2.2.5, is lost to the reactor coolant pump motors, and cannot be restored within 10 minutes. The reactor coolant pumps will also be tripped following the reactor trip. Since both of these operations are performed at the main control board, these evolutions can be performed within the 10-minute time frame.

A failure analysis of pumps, heat exchangers and valves is presented in Table 9.2-9.

9.2.2.4 Tests and Inspections

Those components in the PCCW system which are in either continuous or intermittent use during normal plant operation do not require any additional periodic tests. Automatic isolation valves, such as those provided in the residual and containment spray heat exchanger return lines, and those used for containment isolation, are tested in accordance with Technical Specification requirements. During plant operation, in-service inspection of the Class 2 and 3 portion of the PCCW system is performed in accordance with ASME Code, Section XI.

9.2.2.5 Instrumentation Application

Control and display instrumentation is provided to permit operation of the PCCW system from the main control room under normal and abnormal conditions. The system controls required for safe shutdown are also provided in the remote safe shutdown locations to facilitate safe plant shutdown in the unlikely event of main control room evacuation.

Individual control switches are provided on the main control board (MCB) for each PCCW pump. When the control switch for the preferred pump in a given loop is placed in the "start" position and all electrical interlocks are satisfied, the pump motor circuit will be energized to circulate the cooling medium through the loop. Once the preferred pump is operating, the standby pump control switch is placed in automatic. The standby pump will start automatically if the operating preferred pump trips. Low system pressure is alarmed at the MCB. Operation of both pumps simultaneously for more than a pre-set time period is alarmed at the MCB. Once started, the standby pump will continue to operate until shutdown by the operator. If the pump were operating prior to a loss of offsite power, it will be restarted by an Emergency Power Sequencing (EPS) permit signal.

Three independent head tanks (one for RCPTB loop) provide makeup water to their respective loops. Level instrumentation monitors the tank level and provides the protection logic circuitry to initiate PCCW loop A or B isolation. The levels are indicated and high, low and low-low levels are alarmed on the MCB.

Temperature control instrumentation maintains the PCCW at a constant temperature through a set of reverse-acting positioners which control the bypass and heat exchanger outlet valves. Both valves are positioned simultaneously to provide the desired mixing. The heat exchanger valves can be controlled either from the MCB or from the Remote Safe Shutdown (RSS) panel. Loop temperature and flow indications are provided on the MCB. The PCCW pumps are tripped on high temperature to avoid system overtemperature from a malfunction causing loss of cooling. In addition, high or low temperature and low flow conditions in each loop are alarmed at the MCB. Monitors and/or alarms are provided for the temperatures of the RCP seal cavity, RCP motor bearing and RCP stator to alert the operator upon a loss of PCCW.

The effluent of selected loads supplied by the PCCW system is monitored for low flow conditions. The low flow condition is alarmed if the equipment being served is operating. The flow to each load on the loop is controlled by either a manual pre-set valve or by an automatic valve. The varying conditions controlling the automatic valves are described in the succeeding paragraphs.

The flow of component cooling water through the chemical volume letdown heat exchanger is regulated by the temperature on the tube side of the heat exchanger. The flow of component cooling water through the Residual Heat Removal (RHR) and Containment Spray (CBS) heat exchangers is controlled by motor-operated valves. Control switches on the MCB permit remote manual control of the valves during normal operation. The CBS heat exchanger valves are opened on a "P" signal and the RHR heat exchanger valves are opened on a "T" signal. When opened by the safeguard signal, the corresponding valves cannot be closed until the actuation signal is reset. The signals are discussed in Subsection 6.2.4. The flow of component cooling water to heat loads inside the containment structure is controlled by solenoid pilot valves on both supply and return lines. The containment isolation functions of these valves are shown in Table 6.2-83. Excess flow in the lines serving the reactor coolant pumps is indicative of a thermal barrier rupture. This excess flow is alarmed in the control room and the particular pump cooling water outlet isolation valve is manually closed on a high flow signal. Two Class 1E transmitters are provided to redundantly monitor the combined flow from the upper and lower bearing oil coolers and the motor air coolers for each pair of RCPs served by each PCCW loop (total of four instruments). These safety-related transmitters will provide flow indication on demand and actuate low flow alarms in the control room. Independent alarms will be provided on the annunciator and the Video Alarm System. On a complete loss of flow to both reactor coolant pumps' bearing and motor air coolers, a reactor trip will be manually initiated if PCCW flow cannot be restored within 10 minutes.

The RCPTB pumps are controlled from the MCB as well as the remote Safe Shutdown Panel. The preferred pump starts by placing the control switch into the "RUN" position when the motor overload protection is reset. The standby pump will start automatically on low pump discharge flow. Once the pump starts it will continue to operate until interrupted by the operator.

The thermal barrier heat exchanger isolation valves are manually operated from the MCB. These isolation valves are not automatically closed by a "P" signal to provide continued cooling during a main steam line break, but can be closed manually in the event of abnormalities.

Power to the RCPTB isolation valves is removed at the MCC. For normal plant operation, power to the isolation valves is removed after full opening of the isolation valves. The effluent flow of each RCPTB is monitored for high flow, indicative of a ruptured thermal barrier. Once high flow is detected, the corresponding RCPTB isolation valve closes automatically only when the operator has restored the power by closing a breaker at the MCC.

The thermal barrier head/relief pipe provides storage water to the PCCW RCPTB loop. The tank level instrumentation not only monitors the tank level but also provides low and high level alarms at the MCB.

Adequate component cooling water flow to vital equipment during accident conditions is assured by disconnecting the nonvital loads from the loop. Isolation valves for nonvital loads are provided in the supply and return headers for this purpose. The control circuits for each valve are arranged to close the valves automatically upon receipt of the appropriate "P" or "T" signal (see Subsection 6.2.4), head tank low level (except the spent fuel pool heat exchanger), or they may be closed by control switch action from the control room. Once the valves have been closed, they will remain closed until reset by the operator.

Reset of the automatic valves is inhibited until the conditions originating the automatic action return to normal.

The design bases for the PCCW system control instrumentation is presented in Subsection 7.1.2.1.

Status lights on the MCB provide indication of PCCW isolation valve positions as well as train bypass and inoperable status.

A radiation monitor is connected to the PCCW system and provides display and alarming of PCCW system high radiation conditions in the main control room.

9.2.3 Demineralized Water Makeup System

9.2.3.1 Design Bases

The Demineralized Water System serves no safety-related functions. It is designed as a nonnuclear safety, nonseismic Category I system, except for the containment penetration piping, and containment isolation valves, which are designed in accordance with the ASME Code, Section III, Safety Class 2, seismic Category I requirements. Also, the makeup water piping connections to the PCCW head tanks are designed in accordance with ASME Code, Section III, Safety Class 3, seismic Category I requirements.

The system is designed to provide a sufficient supply of demineralized water at a quality required for operation, makeup, and maintenance of the plant.

9.2.3.2 System Description and Operation

This system consists of a water treatment subsystem and a storage and distribution subsystem. The flow diagram for the Demineralized Water Makeup System is shown on Figure 9.2-7. Table 9.2-10 contains a listing of components with their associated material which are in contact with fluid in the Demineralized Water Makeup System. The water for the makeup system is supplied from a town water main extended into the plant from the town of Seabrook, New Hampshire or from well water. The water supply from the town is of suitable quality for drinking, and no clarifiers or sand filters are required for turbidity control.

The Demineralized Water Makeup System is designed in accordance with the ASME Boiler and Pressure Vessel Code, Sections VIII and IX and ANSI Code B31.1, Code for Power Piping, with exceptions as noted in Subsection 9.2.3.1.

a. Water Treatment Subsystem

The Water Treatment System (WTS) consists of two parallel strings of demineralization equipment which share a common oxygen removal unit.

Each demineralization train includes a permanent plant carbon filter and one of the two trains within a leased makeup water treatment system (LMWTS). The LMWTS is leased from and operated by IONICS, Inc., of Watertown, MA.

The WTS is designed to process up to twenty-four million gallons of fresh water into demineralized and deoxygenated makeup water for secondary plant systems.

The LMWTS includes equipment in each train which provides ultrafiltration (UF) for pretreatment, reverse osmosis (RO) for bulk demineralization, and electro-deionization (EDI) for primary polishing. Deoxygenation is accomplished in a catalytic oxygen removal system (CORS) which is common to both trains. The CORS unit utilizes hydrogen from the plant's bulk hydrogen storage facility in the oxygen removal process. Final treatment is accomplished by two trains of mixed bed polishers. The mixed bed polishers are regenerated off site by IONICS.

Each of the two LMWTS trains is sized to produce 75 gpm of demineralized water.

The quality of the WTS effluent is monitored automatically. Should the product quality be unacceptable, the out-of-specification effluent stream is automatically diverted to the reject effluent line, which discharges to the Circulating Water System discharge line.

The WTS is designed to produce makeup water of the following quality:

Parameter	Operating Limit	Shutdown Limit
Specific Conductivity, mhos/cm (at 25°C)	0.06	0.08
Silica, ppb	5	10
Dissolved Oxygen, ppb	10	20

b. Storage and Distribution System

Water from the water treatment subsystem is directed to either a 500,000-gallon or 200,000-gallon demineralized water storage tank. From here, the water can be transferred to the condensate storage tanks or distributed throughout the unit by means of the Demineralized Water Transfer System. If the demineralized water storage tanks are full or not available, it is possible to bypass these tanks and go directly from the water treatment plant to the condensate storage tank. The demineralized water transfer subsystem supplies initial fill and makeup to the various services within the Turbine, Administration, Containment, Primary Auxiliary, Fuel Storage, and Waste Processing Buildings, and the Condensate Polishing Facility. These services include reactor makeup, primary and secondary component cooling water, auxiliary boiler deaerator makeup, condensate polishing regeneration, emergency showers and eye wash stations, generator stator cooling, and maintenance flushing of systems and components located within the plant.

9.2.3.3 Safety Evaluation

The Demineralized Water Makeup System is not part of the engineered safety systems, and is not required for maintenance of plant safety in the event of an accident.

9.2.3.4 Testing and Inspection Requirements

The equipment is checked prior to startup for integrity, performance and operability. Integrity testing is in accordance with ASME Code, Section III, or ANSI B31.1, as applicable to the particular portion of the system.

9.2.3.5 Instrumentation Requirements

The instrumentation employed for monitoring and controlling the various demineralized water subsystems are as follows:

a. Water Treatment Subsystem

Local flow, level, pressure and temperature indicators are located at the equipment to monitor the process parameters of each demineralizer train.

The parameters which are indicated and/or recorded at the LMWTS control panel and parameters which are alarmed at the panel to warn the operator of impending change of the capability of the water treating equipment and mixed bed resins are shown in Table 9.2-11.

b. Neutralization Subsystem

A Neutralization Subsystem is included as part of the Water Treatment System. Backwashes from the carbon filters as well as the overflows, drains, and spills from the WTS are retained as necessary before being discharged to the Circulating Water System.

The parameters which are indicated and/or recorded on the water treatment control panel and parameters which are alarmed at the panel are shown in Table 9.2-11.

c. Distribution Subsystem

The main demineralized water transfer pumps are operated by control switches from a local control panel. Pump status indicating lights are located with the switches. Low header pressure is alarmed at the main control board and will start the second pump in auto mode. The discharge pressure at each pump, and demineralized water header pressure in the Turbine, Diesel Generator and Administration and Service Buildings are indicated by local pressure gauges.

The condensate polishing system demineralized water pumps are operated by control switches from a local control panel. Pump status indicating lights are located with the switches. Low header pressure is alarmed at the PLC and will start the second pump in auto mode. The header pressure is indicated by a local pressure gauge.

The demineralized water storage tanks are temperature controlled by means of a heat exchanger. Demineralized water is circulated through the heat exchanger and back to the tank. A local temperature controller modulates the steam control valve supplying auxiliary steam to each heat exchanger. Demineralized water temperature is indicated at the tank; low demineralized water temperature is alarmed in the control room.

9.2.4 Potable and Sanitary Water Systems

The plant water system provides water for drinking, sanitary purposes, and makeup water to the fire water storage tanks, cooling tower and the Water Treatment System. The water is supplied from the town of Seabrook's water main which receives its supply from wells described in Subsection 2.4.13.

9.2.4.1 Design Bases

The Potable Water System is designed for a peak demand of 375 gpm with an average demand of 16.6 gpm. The daily demand will be 215,200 gpd which includes 10,000 gpd for sanitary purposes, 46,080 gpd for cooling tower, 720 gpd for chlorination, 14,400 gpd for waste water treatment plant and 144,000 gpd for the fire storage tank.

The Sanitary System is designed for a peak flow of 38,000 gpd/30 gpm during the operating phase and an average daily flow of 7,500 gpd. There are no cross-connections between the Potable and Sanitary Water System and systems having the potential for containing radioactive material (see Figure 9.2-9).

All site sanitary waste is pumped to the Town of Seabrook waste treatment facility for processing.

9.2.4.2 System Description

Potable water received from the town of Seabrook water main is metered at the Fire Pumphouse then piped to the fire water storage tanks and the Plant Distribution System. The fire protection tank fill line is equipped with a backflow preventer. Chlorine injection is provided for control of biological growths in the fire protection tanks and associated piping.

The Water Treatment Makeup System uses the undedicated 200,000-gallon capacity of each fire water storage tank as its source of makeup water.

The distribution system consists of branch mains to the various personnel areas, service water cooling tower fill, the Demineralized Water Makeup System and the fire water storage tank fills. Branch headers and branches lead to the various fixtures. Drinking fountains, eye and face wash fountains, lavatories, urinals, water closets, showers, safety showers, water coolers, water heaters, and special fixtures are provided according to occupancy. Connections are provided to kitchen, laboratory and similar equipment requiring potable water. The branch main to personnel areas is equipped with a backflow preventer and hose bib vacuum breakers to prevent backflow or syphoning.

9.2.4.3 Safety Evaluation

The Potable and Sanitary Water System has no cross-connections with systems having a potential for containing radioactive material or any system containing materials hazardous to personnel health. An air gap exists at the service water cooling tower fill and at both fire water storage tank fills. The connection to the Water Treatment Makeup System is equipped with a reduced pressure backflow preventer. An emergency supply of drinking water in bottles is maintained at the control room. This water is available in the event of a short-term failure in the potable water supply.

9.2.4.4 Tests and Inspections

The system is initially tested and inspected to ensure integrity and completeness.

9.2.4.5 Instrumentation

Potable and sanitary water instrumentation consists of locally mounted pressure indication.

9.2.5 Ultimate Heat Sink

9.2.5.1 Design Bases

The ultimate heat sink complex, consisting of the Atlantic Ocean and atmosphere, is designed to meet the requirements of Regulatory Guide 1.27. The Atlantic Ocean serves as the normal ultimate heat sink (Figure 9.2-10) for Seabrook Station. However, in the unlikely event that the normal supply of cooling water from the Atlantic Ocean is unavailable, the atmosphere serves as the ultimate heat sink through the use of a mechanical draft evaporative cooling tower.

a. Atlantic Ocean

The Atlantic Ocean serves as the normal supply of cooling water and as the ultimate heat sink for Seabrook Station. The Atlantic Ocean portion of the ultimate heat sink (Figure 9.2-10) includes two tunnels; one tunnel, from the submerged intake structure offshore to the Station Pumphouse at the plant site, normally serves as an inlet; a second tunnel discharges cooling water to the ocean.

The intake tunnel is designed to supply sea water from the Atlantic Ocean to the Station Service Water System (Subsection 9.2.1) during all normal operating and accident conditions. Provision is made to ensure a sufficient flow of cooling water via the intake tunnel from the ultimate heat sink to the Service Water System Pumphouse during a loss-of-coolant accident occurring simultaneously with a loss of offsite power and any single active failure.

The Atlantic Ocean portion of the ultimate heat sink is designed to perform all safety functions during and following the most severe natural phenomena anticipated, e.g., the safe shutdown earthquake (SSE), tornado, hurricane, flood or low water level resulting from storm surges (see Subsection 2.4.11.2), with the exception of the tunnels and transition structure which are not designed for the SSE. In the unlikely event that an earthquake of sufficient intensity occurs, which blocks over 95 percent of the flow area of the intake tunnel, the cooling tower would be used as the ultimate heat sink.

b. Cooling Tower

In the unlikely event that the main circulating water tunnel is unavailable, a mechanical draft evaporative cooling tower (Figure 9.2-10) serves as the ultimate heat sink. The cooling tower is designed to supply cooling water to the primary component cooling water and diesel heat exchangers while sustaining a loss of offsite power and any single active failure. When the reactor is defueled, and primary component cooling water would otherwise not be required, the cooling tower can supply the alternate spent fuel pool cooling heat exchanger for removal of decay heat. The Atlantic Ocean serves as a backup while in this mode. The tower, tower pumps and all its associated components are designed for the safe shutdown earthquake loads which, therefore, assures that cooling water will be available from the ultimate heat sink complex during and following all natural phenomena as required by Regulatory Guide 1.27.

Design features, applicable to the Ultimate Heat Sink Cooling Tower, are amplified in referenced Updated FSAR sections below:

Design Feature	Updated FSAR Reference Section
Protection Against Tornado and Hurricane Wind Effects	3.3
Protection Against Floods	3.4
Protection Against Postulated Missiles	3.5
Protection Against Dynamic Effects Associated with Postulated Pipe Ruptures	3.6

9.2.5.2 System Description

a. Atlantic Ocean

The Atlantic Ocean portion of the ultimate heat sink includes the intake and discharge tunnels and the piping connecting the tunnels to the Service Water Pumphouse, as shown in Figure 9.2-10. Neither the main condensers nor the Circulating Water Pumphouse is part of the ultimate heat sink.

Refer to Subsection 9.2.1 for a description of the Station Service Water System.

b. Cooling Tower

The Mechanical Draft Cooling Tower provides an alternate source of cooling water which is completely independent of the circulating water tunnels and the Atlantic Ocean.

In the unlikely event that level is lost in the Service Water Pumphouse, the heat loads are transferred from the Atlantic Ocean to the cooling tower.

The cooling tower is used as the ultimate heat sink cooling water source when the reactor is defueled and primary component cooling water would, otherwise, not be required. During this shutdown mode, the cooling tower provides cooling to the diesel heat exchanger and the alternate spent fuel pool cooling heat exchanger. In the unlikely event that the cooling tower is unavailable, the Atlantic Ocean will supply cooling to these components.

Transfer of heat loads to the cooling tower can be performed manually on a system or component level from the main control board. Automatic transfer will occur on a train basis upon actuation of the associated tower actuation logic. The tower actuation (TA) logic, associated with each train, senses service water pump discharge pressure. A low pressure condition, indicative of a low-low service water pumphouse level, will initiate tower actuation for the associated service water train.

A tower actuation signal (TAS) from the associated service water train will transfer that train from ocean water cooling to cooling tower basin water cooling. The return flow initially bypasses the tower sprays and is returned to the basin. When outside wet bulb temperature (WBT) is above freezing, the fans and sprays are required to be manually started within 106 minutes of the TAS, except when accompanied by a "P" signal LOCA. Approximately 74 minutes after a TAS with simultaneous "P" signal LOCA, 51 minutes after the RHR and CBS system flow valves are opened, cooling tower fan and spray operations are initiated. During cold weather, to avoid an ice buildup on the tower tile fill, the fans and sprays are operated in accordance with appropriate Operating Procedures. If the temperature information necessary for maintaining the temperature limits is not available after a seismic event, an appropriate operations procedure is used to assure the required function of the tower cooling trains is maintained.

In order to maintain the tower and basin flow paths in the ready condition during all wintertime conditions, an appropriate operations procedure is used to assure that ice formation on the tower and basin will not degrade the required function of the tower cooling trains. Piping located in the unheated Cooling Tower pipe chases is provided with redundant nonsafety-related electrical heat tracing circuits fed from the safety-related emergency busses.

The cooling tower complex is that portion of the ultimate heat sink that includes a three (two of which are functional) cell tower, a basin with five (three of which are functional) interconnected compartments, two (one of which is functional) pump rooms and the associated piping, valves and equipment as shown on Figure 9.2-1 and Figure 9.2-2. The functional portion of the cooling tower consists of one independent cell with one fan and a center cell with two fans. The functional portion of the basin consists of a pump well and one catch basin for each of the two functional tower spray cells. The unit has an "A" and a "B" cooling tower complex flow train. The pumps with associated valves, piping and equipment in the trains circulate cooling water from the pump well basin through the primary component cooling heat exchangers and the secondary component cooling heat exchangers during normal operations or the diesel generator heat exchangers during loss of offsite power conditions or both during test. The flow is returned to the basin through either the respective tower sprays or through the spray bypass header which distributes the return flow to each of the two tower cell catch basins. A heat exchanger bypass line is provided from each pump discharge to the return line permitting cooling tower spray or spray bypass header recirculation independent of normal ocean cooling operations. There is an orifice in each line sized for pump full flow to the deicing header (spray bypass).

The configuration and operation are modified as follows:

1. Both center cell fans are powered by the "B" train diesel generator during a loss of offsite power.

2. The unfinished former Unit 2 lines that could be pressurized by Unit 1 operation are blanked off.

3. The unfinished former Unit 2 pump well basin compartment integrity is required to provide the needed water inventory for Unit 1 operations. Because there is no circulation and no heating in the compartment during Unit 1 operations, an appropriate operations procedure is used to assure that the unfinished former Unit 2 pump sump basin ice formation will not degrade the required function of the tower cooling trains.

4. Cooling tower pump recirculation valves, SW-V-26 and SW-V-55, are locked out in the closed position, because their repositioning is not required during Unit 1 operations. These valves may be used to supply the alternate spent fuel pool cooling heat exchanger during refueling.

   To permit continued tower availability during construction of the unfinished former Unit 2, the associated return piping to the center cell and tower bypass connections are blanked off.

   Design parameters for the tower and associated equipment are listed in Table 9.2-12. A summary of tower heat loads and flows is shown in Table 9.2-13.

9.2.5.3 Safety Evaluation

a. Atlantic Ocean

The design of the ultimate heat sink using the Atlantic Ocean assures that the sink safety function is not compromised following tornado, hurricane, flood, or low water level conditions. In the event of a seismic (or any other) incident of a magnitude which causes the failure or loss of the circulating water tunnels, cooling water can still be supplied from a mechanical draft, seismic Category I evaporative cooling tower. However, use of the cooling tower would only be necessitated by 95 percent blockage of a circulating water tunnel. The total flow required for the performance of the sink safety function is less than 5 percent of the circulating water flow rate provided during normal full power operation. A catastrophic failure of the tunnels resulting in complete blockage and cessation of flow to the Service Water Pumphouse would require transfer to the cooling tower which is a seismic Category I structure.

b. Cooling Tower

The seismic Category I Mechanical Draft Cooling Tower provides an alternate source of cooling water which is completely independent of the circulating water tunnels and Atlantic Ocean. The tower is designed to provide sufficient cooling capacity during a loss-of- coolant accident. The tower is designed to accommodate these accident heat loads while sustaining any single active failure. Each train-associated tower pump, fan, and associated electrical equipment serving a single primary component cooling water heat exchanger has a common emergency electrical power supply and is separated from the other train's power supply. A loss of power to the electrical equipment supplying one flow train would affect only that flow train and would still allow sufficient capacity for cooling the unit under a LOCA condition.

The single failure of an isolation valve between the cooling tower and seawater tunnels was reviewed with respect to the potential for tower pumpdown, and it was determined that the amount of water lost must be limited to assure that the required amount of water is available.

For the severest conditions above, one primary component cooling water heat exchanger is manually secured, reducing total tower flow requirements while satisfying minimum safeguard requirements. Failure of any single component in this mode is accommodated by shutting down the affected flow train after transferring heat loads to the redundant train. This operating philosophy assures continued availability of the redundant train components and reduces unnecessary electrical and heat loads.

Since all tower electrical components in each train are powered by train-associated power supplies, a failure of a power supply train or component will not preclude the tower from performing its safety function.

For the case when Unit 1 is operational and the former Unit 2 is unfinished, one diesel powers the fan in the independent cell serving Unit 1, and the second diesel powers both fans in the center cell. Sufficient thermal capacity is available to accommodate loss-of-coolant accident heat loads assuming a single failure including the failure of a diesel generator and the attendant loss of both center cell fans under this condition.

The design meteorological conditions for the tower comply with those specified in Regulatory Guide 1.27.

The cooling tower and makeup basin which is founded on rock is designed to meet seismic Category I requirements. In addition, the entire structure is designed to withstand wind loads resulting from tornadoes. Only those portions of the cooling tower structure which protect service water piping up to and including the cooling tower pump discharge valves require tornado missile protection (see Subsection 3.5.2). Of the nearly $4x10^6$-gallon basin capacity, approximately $1.9x10^6$-gallons of water is stored in the basin below grade. Sufficient water is stored in the cooling tower basin to meet submergence requirements for the cooling tower pumps of 4.25 feet above the pump bell. The cooling tower pumps are seismic Category I and designed in accordance with ASME Section III, Class 3. The pumps are enclosed within the tower structure. All tower piping is either buried or contained within the tower structure. That portion of the service water piping up to the cooling tower pump discharge valves is protected from all credible missiles. Piping which services the alternate spent fuel pool cooling heat exchanger is either buried or shown to have an acceptably low probability of tornado wind/missile induced failure. The piping is designed in accordance with ASME Section III, Class 3 and seismic Category I requirements.

c. <u>Tower Basin Water</u>

The average basin water temperature is maintained below the value listed in the Technical Specifications during warm weather conditions to provide sufficient thermal mass. This mass and the design operating atmospheric conditions are based on the design meteorology, which is described in Subsection 2.3.1.1 and modified by a probability analysis.

The plant accident analysis utilizes the thermal mass of the basin water and outside air temperatures to establish design limits. The basin thermal mass and design operating atmospheric conditions are based on the design meteorology which is described in Subsection 2.3.1.1 and modified by a probability analysis. The basin water level and temperature is manually controlled, and operator functions (operations based on observations if necessary) are performed within 10 minutes of a TA to assure the availability of the required thermal mass. The basin water level is maintained above the technical specification limit which provides sufficient water inventory for the operator to detect and terminate basin pumpdown from the single failure of an isolation valve, where the valve remains open following a TA. The average basin water temperature is maintained below the Technical Specification temperatures. During warm weather conditions, the basin temperature is maintained by monitoring basin temperature and cooling it by recirculation through tower sprays when low wet bulb temperatures are available. Basin integrity can be degraded by the formation of ice on the surface of the water; therefore, during freezing weather conditions, an appropriate operations procedure is used to assure that prior to and during an accident, the formation of ice on the basin water surface will not degrade the required basin water functions, and the average basin water temperature will not rise above allowables.

Sufficient tower basin water is stored in the tower basin for seven days of operation during accident conditions. Following the seven-day period and assuming town water is not available, any of the four service water pumps that are installed may be used to transfer makeup water from the pumphouse bay to the cooling tower basin. In the unlikely event that cold sea water is not available from the intake tunnel, an event that is only possible if a large seismic disturbance occurs when the tunnel flows are reversed during heat treatment operations, a portable pumping system is used to provide the makeup water. Assuming the intake tunnel is restricted due to a seismic occurrence, seepage through the tunnel blockage of 140 gpm (after 7 days) would satisfy tower makeup requirements for one unit operation in accordance with Regulatory Guide 1.27.

The Safety Grade Service Water System can conveniently be used to transfer pumphouse water to the tower basin. After one of the service water pumps (SWP) is started, the cooling tower pump (CTP), which is operating in parallel with the SWP, is tripped. Then, service water flows through the primary component coolers and the diesel generator coolers before it is discharged through the tower sprays into the basin. The service water flow rate at normal ocean temperature is sufficient to remove the accident condition heat from the coolers. Near the completion of the makeup pumping cycle when either the tower basin becomes full or the pumphouse water level reaches minimum, one of the CTPs must be returned to service before the SWP is tripped. Except during the periodic tunnel heat-treating operation, the Service Water Pumphouse bays are connected to the intake tunnel transition structure, which at low tide contains 750,000 gallons above the level required for pump NPSH. Sixty-five minutes of service water system pumping on a forty-one hour interval is required to transfer the pumphouse water to the tower basin. With extended tower operation the plant cooling load will decrease, the tower makeup requirements will decrease, and because the 150 gpm intake tunnel inleakage will exceed the Unit 1 makeup requirements, the tower basin will become filled. Because the temperature of the cooling water from the discharge tunnel could exceed the temperature requirements, it is not used for SWP basin makeup. After basin filling, the time interval between service water makeup cycles can be extended.

In addition to the Service Water Pumping System, a portable tower makeup pump is maintained on the site. It is capable of providing makeup water to the tower basin (without temperature limitation) from the nearby Browns River or Hampton Harbor with several locations accessible by road. It consists of 3000 feet of 5-inch ID rubber-lined polyester flexible hose in 30-100 foot lengths, associated hose couplings and a portable diesel-driven pump that is self-priming within 15 feet of water level, and is designed to deliver a minimum of 200 gpm from the water source to the tower basin. The seven-day period that the tower can operate without makeup water provides sufficient time to move the pump into position, lay the hose and make the system ready for operation.

The dose to station personnel filling the basin after 5 days is minimal. Direct radiation from the containment is less than $1x10^{-3}$ mr/hr.

The level of the cloud dose is acceptable, and can be minimized or completely avoided by taking water from sources upwind of the containment or by taking water from the pumphouse.

Cooling tower makeup water is required to account for losses of tower coolant due to evaporation, drift losses, and tower blowdown.

Of these, evaporative losses consume the largest portion of the required makeup water, and drift losses are relatively small.

Drift losses of 0.03 percent of the tower circulating water flow rate have been conservatively assumed for the tower. Sufficient makeup water is provided in the tower basin to account for this loss. Evaporative losses from the tower are based on the integrated heat loads listed in Table 9.2-14. These losses were calculated using analytical methods accounting for both the latent heat of vaporization of the coolant and sensible heat transfer from the coolant to the air assuming saturated exit air. To assure adequate makeup supply, the basin capacity was also calculated using an alternate method which conservatively neglects sensible heat transfer and assumes all of the heat transferred is used to evaporate tower coolant. This assures that sufficient makeup water is available in the tower basin for seven days of tower operation and that minimum cooling tower pump submergence requirements are satisfied at all times.

Since the cooling tower basin is initially filled with fresh water, the tower will not be blown down during operation when serving as the ultimate heat sink. A relatively small amount of salt water (less than 200,000 gallons) in the service water lines will be highly diluted in the tower basin and will have no effect on the tower performance without blowdown.

Based on the above considerations, a basin capacity of nearly four million gallons provides more than adequate makeup for the cooling tower for seven days. A continuous flow of 140 gpm, provided by portable pumps from the Browns River, Hampton Harbor, the pumphouse, or seepage through the postulated failed tunnel, will meet requirements for the duration of tower operation.

Although the cooling tower makeup basin is initially filled with fresh water, the tower, fill, and all associated components are designed for use with salt water. Less than 200,000 gallons of salt water in the service water lines will be diluted in the basin volume and will have no effect on the tower's capacity to satisfy the sink safety functions. In the event that the tower is operated for any reason during normal plant operations, the concentration of salts in the basin will be monitored. If necessary, the tower will be blown down and replenished with fresh water.

d. Ultimate Heat Sink Complex

Considering the ultimate heat sink in total as the Atlantic Ocean and the cooling tower, the sink safety function is assured following the most severe natural phenomena including the safe shutdown earthquake, tornado, hurricane, flood, or loss of water level and meets the requirements of Regulatory Guide 1.27.

9.2.5.4 Tests and Inspections

During the initial test program, the ultimate heat sink is tested as described in Chapter 14.

During plant operation, in-service inspection of the Class 3 portion of the ultimate heat sink is performed in accordance with ASME Code Section XI.

Provisions are made for testing the portable makeup equipment for the cooling tower.

9.2.5.5 Instrumentation Application

Control and display instrumentation in the ultimate heat sink is provided in both the primary and secondary control locations, in accordance with GDC 19.

Transfer from the Atlantic Ocean to the cooling tower is possible from the primary location only. The primary control location for system pumps, fans and valves is in the main control room with the secondary location being the control building switchgear room. The controls for all the pumps and valves associated with the ultimate heat sink satisfy the requirements of redundancy and separation as set forth in IEEE Std-279 and NRC's Attachment C, "Physical Independence of Electric Systems" (Updated FSAR Appendix 8A).

Seawater level in each Service Water Pumphouse is indicated on the main control board (MCB), and is available for alarm and display via the Main Plant Computer System. Tower return flow is also indicated and alarmed at the MCB.

Cooling tower basin temperature instrumentation provides alarms in the main control room.

Transfer to the cooling towers is accomplished manually or via a tower actuation signal.

The individual train tower actuation (TA) signal is generated when the Pump Discharge Pressure Coincident Logic System determines that flow in that train decreases to the predetermined pressure setpoint, indicative of failure of the nonsafety piping or low-low intake level. The logic system automatically initiates the transfer of the train to tower operation based upon coincidence logic to reduce the incidence of inadvertent transfers. The TA signal is also generated when the cooling tower is providing the cooling water to the station, and a loss of offsite power event occurs. The operator can also manually initiate the TA signal from the MCB. Once a TA signal is initiated, the transfer of that particular train to tower operation will be completed automatically. All manual controls will be blocked until the TA signal is reset by the operator. This transfer operation includes automatically shutting down and isolating the service water pumps, starting the cooling tower pumps and repositioning valves to permit closed loop coolant flow from the cooling tower basin and to isolate the nonsafety piping. The nonsafety SW piping is also isolated on loss of offsite power and safety injection.

Operator reset of the TA signal permits realignment of valves as might be required to reduce total tower heat load. The cooling tower spray bypass valves and fans are controlled manually from the MCB.

During severe winter operation, the cooling tower fans and spray bypass valves are manually controlled at the MCB, and provide control of the heat removal to prevent ice buildup in the cooling tower fill and basin.

The tower basin contains independent level transmitters which provide for indication, recording, and alarming of the basin level at the MCB. If there is a loss of level in the basin, the tower return lines contain flow indication which help the operator identify a failed line and permit its isolation. The tower basin level indication is safety-related. This indication provides operator information regarding proper operation of the ultimate heat sink.

9.2.6 Condensate Storage Facility

9.2.6.1 Design Bases

The condensate storage facility design bases are:

a. To provide makeup capacity to compensate for changes in the water inventory of the Steam and Power Conversion System during normal operation and transient conditions.

b. To maintain sufficient water storage to satisfy the requirements of the Emergency Feedwater System (EFS) during all periods of plant operation.

c. To meet the requirements of the General Design Criteria regarding seismic and tornado protection.

9.2.6.2 System Description

The condensate storage facility is shown in Figure 10.4-6 and Figure 10.4-7. It consists of the condensate storage tank, the condensate transfer pump, the condensate storage tank heat exchanger, and all associated piping.

The condensate storage tank is fabricated from stainless steel, and is located outdoors in the yard area, adjacent to the Turbine Building. The tank is equipped with a stainless steel floating cover to preclude excessive oxygenation in the contained water. Except for the tank roof, it is completely encircled by a reinforced concrete wall that provides tornado missile protection. The tank is vented to the atmosphere and has a total capacity of approximately 400,000 gallons at the overflow connection. Half of this capacity is maintained for use by the Emergency Feedwater System, while the remainder acts as makeup capacity for the Condensate System. All non-seismic tank connections are physically located at a height sufficient to guarantee that EFS requirements are maintained. The EFS supply lines are taken from near the tank bottom.

During normal operating conditions, the condensate storage tank (CST) is filled from the demineralized water storage tanks, using the demineralized water transfer pumps. However, it is possible to fill the CST directly from the Water Treatment System in the event that the demineralized water storage facility is unavailable. During the winter months, the condensate storage tank is protected from freezing by a heated closed recirculation loop. This loop includes the condensate transfer pump and the condensate storage tank heat exchanger, and is locally/manually initiated. Water is then drawn from the storage tank by the transfer pumps and pumped through the heat exchangers where it is warmed, and returned to the tank.

The storage tank and the piping associated with the Emergency Feedwater System are designed in accordance with the ASME Boiler and Pressure Vessel Code, Section III Class 3. The seismic requirements of the facility are defined in Subsection 3.2.1. All other components are nonnuclear safety class (NNS), with their associated piping designed in accordance with ANSI B31.1, Code for Power Piping.

9.2.6.3 Safety Evaluation

The condensate storage facility meets the design, material and fabrication requirements of a Safety Class 3, seismic Category I system. Of the total capacity, 196,000 gallons are reserved to meet the requirements of the Emergency Feedwater System (see Section 6.8).

Leakage from the condensate storage facility is minimized by using welded connections wherever practical. Leakage can be detected by visual inspections and unexplained loss of tank inventory.

The chart below can be used with Figure 10.4-6 and Figure 10.4-7, to locate tank connections for nonnuclear or Safety Class 3 piping. The centerline elevation and wall thickness for each nozzle is also indicated, so that the invert elevations of each nozzle can be determined.

Nozzle Class	Size	Wall	Thickness	Elevation	Connecting Pipe
A	24"	3/8"	(0.375")	25' - 3"	3
B	16"	3/8"	(0.375")	45' - 0"	NNS
C High	6"	40S	(0.280")	47' - 0"	Capped
C Low	6"	40S	(0.280")	25' - 6"	3
G	6"	80S	(0.432")	63' - 2½"	NNS
H	8"	40S	(0.322")	24' - 3"	3
J	8"	40S	(0.322")	24' - 3"	3
L High	2"	40S	(0.154")	45' - 0"	Capped
L Low	2"	40S	(0.154")	25' - 6"	3
P	12"	40S	(0.375")	45' - 0"	Capped
R High	4"	40S	(0.237")	64' - 6"	Capped
R Low	4"	40S	(0.237")	25' - 6"	3
S	2"	40S	(0.154")	24' - 6"	3
X	1"	40S	(0.133")	28' - 6"	3(Thermowell)
Bottom of Tank	-	-		23' - 6"	-

The lowest invert elevations of NNS pipe CO-4097-01-D4-16" is 44' 4", the lowest CST level that supports EFW pump operation is 24'-6". The difference in height is 19'-10". The CST has an inside diameter of 42'-0". Postulating a NNS pipe rupture, approximately 205,860 gallons of EFW would remain in the CST. Of this 205,860 gallons, 204,240 gallons will be available due to the draft of the floating cover. Therefore, a minimum storage of 196,000 gallons is assured.

Should a tank failure occur, the water released by the rupture would be contained within the concrete enclosure. The reinforced concrete foundation design for the CST will prevent EFW from leaking out of the bottom of the structure should the bottom of the stainless steel tank become punctured by a vertical missile.

Should a missile enter the top of the CST and exit through the side, water lost from the tank will be contained in the annular space between the tank and the concrete missile shield wall. The initial water volume is assumed already at its minimum (El. 44'-4") prior to a postulated missile strike.

The postulated missile is assumed to exit the tank at an elevation that maximizes the amount of EFW trapped in the annular space. The corresponding volume of trapped water unavailable for EFW use is 3,160 gallons.

Based on the minimum initial volume of 205,860 gallons available, the postulated missile would result in a remaining available volume of 202,700 gallons. Thus, a minimum storage of 196,000 gallons is assured.

It is possible to recirculate the emergency feedwater pumps back to the condensate storage tank. This is administratively controlled from the control room and is based on the pump minimum flow requirements. Normally, the recirculated water will be returned under the floating cover. If plant operators are recirculating during the final 3- inches of cover descent, emergency feedwater will flow over the cover rim and be deposited on top of the floating cover, becoming unavailable for use. A total of 3,940 gallons could become removed in this scenario.

A missile which hits the pan-shaped floating cover will render it unable to hold water on top. A missile which punctures the top of the condensate storage tank above the missile barrier and exits below the invert of nozzle B (El. 44'-4-3/8") will also hit the floating cover. Therefore, the greater of the two scenarios is postulated, i.e., the loss of 3,940 gallons.

Since at the initial tank elevation, 204,240 gallons are available for EFW supply, this leaves over 196,000 gallons designated for EFW use. The minimum condensate storage tank level allowable by Technical Specifications is 212,000 gallons of indicated volume. The total unusable volume in the tank is 15,921 gallons comprised of the draft of the floating cover, the inventory trapped on top of the floating cover, and instrumentation inaccuracy. Therefore, a minimum storage of 196,000 gallons is assured.

Each of the redundant EFW lines has at its origin inside the CST a piping tee. This tee will give two possible flow paths to each of the redundant EFW lines. These EFW nozzles are located approximately 10 feet apart. The entire surface of the floating cover deck is covered with polyethylene foam which prevents sinking should water flood the pan shaped cover. Debris would have to block more than 50 percent of both ends of each EFW connection in order to restrict sufficient flow from reaching the EFW pumps.

The environmental effects of a tank failure would be inconsequential due to the containment of the released water. As a result, there are no specific limitations of radioactivity concentrations for a rupture associated accident of this tank.

With the exception of the condensate storage tank, the suction piping from the tank to the emergency feed pumps, and the EFW pump(s) recirculation line, the condensate storage facility is not required for plant safety. It is not expected to contain any radioactive contamination during normal operation. Radioactive contamination can only occur through carry-over of radioactivity during a surge in the condensate system which results in recirculation from the condensate or startup feed pump discharge to the condensate storage tank, when a steam generator tube leak exists. Due to the radioactive monitoring which is provided, and the length and complicated path that the contaminated condensate must take prior to its settling in the CST, the level of activity expected is low and, in any event, will be contained within the plant boundaries. See Section 11.2 for expected levels of contamination.

The EFW system is designed to operate continuously to effect cooldown to RHR system cut-in. The limiting transient with respect to condensate storage tank inventory requirements is the loss-of-offsite power transient. In the event of a loss-of-offsite power, sufficient condensate storage tank useable inventory must be available to bring the unit from full power to hot standby conditions, maintain the plant at hot standby for 4 hours, and then cooldown the Reactor Coolant System to the residual heat removal system cut-in temperature (350°F) in 5hrs.

The analysis of this event is based on the following assumptions:

- Reactor trip occurs from 100% of the analyzed core power level of 3659 MWt (3678 MWt NSSS power level) from a low-low water level in the steam generators. A two second delay is assumed before reactor trip following loss of offsite power.
- Steam is released from the steam generators at the first safety valve setpoint plus accumulation plus setting tolerance for drift.
- Steam generator level is restored and maintained above the level setpoint (26% of wide range span) that requires initiation of primary side feed and bleed operation.
- The condensate storage tank operating fluid temperature is at the maximum allowable value (100°F).

The analysis concludes that a minimum usable condensate storage tank inventory of 196,000 gallons meets the licensing bases and permits level in the steam generators to be restored and maintained at 58% of wide range span.

For a discussion of EFW system operation with an assumed single failure, see Subsection 6.8.3 and Table 6.8-2. The entire usable volume of the CST (370,000 gallons if full) would be available for EFW supply. Also, the contents of the condenser hotwells and the demineralized water storage tank (nonsafety-related) could be utilized through nonsafety transfer pumps and interconnecting piping.

For Station Blackout, EFW will operate during the four-hour coping duration to cool down and maintain the secondary side pressure at about 250 psig (see Section 8.4.4.1). The amount of CST water required to support this operation is 137,000 gallons, including consideration of decay heat removal, sensible heat removal and steam generator level shrinkage. This is less than the CST 196,000 gallon dedicated EFW supply.

9.2.6.4 Tests and Inspections

The Condensate Storage System is functionally tested during the preoperational testing of both the condensate and Emergency Feedwater Systems. Occasional visual inspection of the tank and associated piping will be performed during plant operation to insure system integrity.

9.2.6.5 Instrumentation

Various instruments are employed to monitor and control the following parameters at the condensate storage tank:

a. Since the condensate outlet connection and other balance-of-plant tank connections are at a high elevation on the condensate storage tank, an adequate tank inventory for the Emergency Feedwater System is assured without the use of any safety-related instrumentation. A level-indicating switch is provided which closes the hotwell makeup valve to prevent air from entering the hotwell through the condensate outlet connection on low tank level.

   System piping from the condensate storage tank to the level transmitters is Safety Class 3, seismic Category I. Both level transmitters are redundant, provide level indication on the main control board, and are protected in a seismic Category I structure. Should any seismic event cause both transmitters to fail, and additionally require the use of the EFW system, the 196,000 gallons reserved in the tank would provide at least 9 hours of EFW system operation before an alternate water supply is necessary. This time frame provides ample time for the operators to recognize the level indication failure and provide an alternate means of level indication.

The CST is provided with the following level instrumentation:

1. Two level transmitters for level indication and high/low level alarm at the MCB

2. A level indicating switch to control tank makeup

3. Indirect CST level indication is also provided by Class 1E pressure transmitters at the suction of each EFW pump. This suction pressure is indicated on the main control board.

b. Level is indicated locally at the tank, and transmitted to the control room by two transmitters for display at two separate indicators, and for input to the Main Plant Computer System.

c. Level, corresponding to approach to over-fill and approach to minimum reserve, is alarmed in the control room.

d. A condensate transfer pump recirculates condensate storage tank water through a heat exchanger which uses auxiliary steam as the heating medium. A local tank thermocouple in conjunction with a temperature control loop controls the condensate transfer pump and a steam control valve to maintain water temperature at 50°F minimum.

e. Tank temperature is indicated locally. Recirculated water temperature is indicated locally at the heat exchanger inlet and outlet.

f. Tank low temperature is alarmed at the control room and at the local control panel.

9.2.7 Reactor Makeup Water System

The function of the Reactor Makeup Water System is to provide for the storage and distribution of reactor grade water. It also provides storage capacity for water recycled by the Boron Recovery System.

9.2.7.1 Design Bases

The system has no emergency function and is not required for emergency reactor shutdown. Accordingly, it is classified as a nonnuclear safety class system except at interface points with safety class systems.

In accordance with the guidelines set forth in ANSI N18.2, the Reactor Makeup Water System, including appropriate isolation valves, is classified as Safety Class 2 where the system penetrates the reactor containment, as Safety Class 2 or 3, as applicable, at the system interface with the Chemical and Volume Control System, and as Safety Class 3 at the system interface with the Containment Spray System.

In accordance with the guidelines set forth in NRC Regulatory Guide 1.29, the Reactor Makeup Water System, including the appropriate isolation valves, is classified as seismic Category I where the system penetrates the containment and at the interfaces with the Chemical and Volume Control System and Containment Spray System.

A summary of demands on the system is given in Table 9.2-15. All demands on the Reactor Makeup Water System are intermittent. Three of these requirements provide the design basis for system capacity:

a. The Reactor Makeup Water System is designed to be capable of providing reactor coolant makeup water to the boric acid blender of the Chemical and Volume Control System at a flowrate equal to the maximum letdown flow of 120 gpm at a pressure of 95 psig at the blender.

b. The Reactor Makeup Water System provides makeup water to the pressurizer relief tank at a rate of 150 gpm and a pressure of 65 psig at the relief tank inlet.

c. The Reactor Makeup Water System also supplies water for back-flushing components in the resin sluicing system in the Waste Processing Building following sluicing operations. The flow required is 200 gpm at atmospheric pressure.

9.2.7.2 System Description

The Reactor Makeup Water System consists of one reactor makeup water storage tank, two redundant, full capacity reactor makeup water pumps and associated piping, valves, instrumentation and controls. A summary of principal component data is presented in Table 9.2-16. The system flow diagram is shown in Figure 9.2-11.

The reactor makeup water storage tank is located in an enclosure between the Primary Auxiliary Building and the Waste Processing Building. The tank is equipped with an internal floating cover to preclude the diffusion of air into the makeup water. Steam heating panels encircle each tank to provide freeze protection. Minimum water temperature is maintained at approximately 45 to 55°F.

The unit has two reactor makeup water pumps. Each pump has sufficient capacity to supply the expected loads. The reactor makeup water pumps are located on the 7'-0" level of the Primary Auxiliary Building. Because the reactor makeup water pump has a drooping head characteristic at low flow, a restrictive orifice maintains a minimum recirculation flow to the reactor makeup water storage tank. This orifice is sized to allow sufficient pump flow to ensure operation at a stable point on the pump curve. A manual bypass valve at the restrictive orifice allows larger recirculation flows for tank recirculation prior to sampling.

The supply line to the Waste Processing Building is controlled by a pressure-reducing valve to avoid exceeding the design pressure of the equipment in the Spent Resin Sluicing and Boron Recovery Systems.

The Reactor Makeup Water System is sampled and analyzed periodically to the chemistry specifications provided in the EPRI PWR Primary Water Chemistry Guidelines and implemented in the Chemistry Manual. System makeup is provided by the Demineralized Water System and the Boron Recovery System. The water from the Boron Recovery System is recycled water and contains low levels of tritium. Demineralized water is provided as the normal supply source to the reactor makeup water storage tank through dual isolation valves. The system's tandem two valve isolation and backup check valve with a spool piece provides the capability to prevent tritium contamination of the Demineralized Water System if the Boron Recovery System is used for RMW tank fill. The Demineralized Water System is monitored periodically to ensure compliance with the chemistry specifications for RMW, except for boron. Prior to transferring makeup water from the Boron Recovery System, the content of the recovery test tank is sampled for specifications for reactor makeup water as specified in the EPRI PWR primary water chemistry guidelines and implemented in the Chemistry Manual.

9.2.7.3 Safety Evaluation

The Reactor Makeup Water System has no safeguard function. The system is accordingly classified nonnuclear safety, nonseismic Category I, with the exceptions described in Subsection 9.2.7.1, Design Bases. The only redundant feature in this system is the spare reactor makeup water pump.

9.2.7.4 Tests and Inspections

The Reactor Makeup Water System is tested to insure system integrity. A description of system acceptance testing is contained in Chapter 14.0. In-service inspection of safety class portions of the system is conducted in accordance with the ASME Code Section XI, where required.

9.2.7.5 Instrumentation and Control

The reactor makeup water pump controls are provided at the main control board (MCB). Normally, one of the two pumps will be kept in "auto," while the other is in the "off" position. The pump in "auto" mode will be started automatically on a signal from the Reactor Coolant Makeup Control System (see Subsection 9.3.4). The spare pump in the "off" position will not start automatically on failure of the other pump. The pumps can also be started manually from the MCB. Each pump is provided with local discharge pressure indication, and the common discharge header pressure is indicated at the MCB. When the system is in operation, the low pressure condition is alarmed at the MCB.

The reactor makeup water storage tank level is indicated locally and also at the MCB. High and low levels in the tank are alarmed at the MCB. Flooding within the dike also is alarmed at the MCB. Freeze protection is provided through a temperature controller and Auxiliary Steam Supply System. A minimum temperature of about 45° to 55°F is maintained automatically. The tank temperature is indicated locally, and high and low temperatures are alarmed at the MCB.

A makeup water isolation valve for piping supplying loads inside the Containment Building is provided, and is automatically closed on a containment isolation "T" signal (see Subsection 6.2.4 and Table 6.2-83). Manual control is also provided at the MCB.

Also, provisions are made for remote operation of the following valves in the system:

a. Makeup water valve to the pressurizer relief tank of the Reactor Coolant System

b. Makeup water valves to the standpipes of the reactor coolant pump No. 3 seals

c. Flushing water valves to the filter elements of the resin sluice tanks.

9.3 PROCESS AUXILIARIES

9.3.1 Compressed Air System

9.3.1.1 Design Bases

The Compressed Air System is a nonnuclear safety class system designed for maximum operating reliability. The Compressed Air System is shown in Figure 9.3-1, Figure 9.3-2, Figure 9.3-3, Figure 9.3-4, Figure 9.3-5, Figure 9.3-6, Figure 9.3-7, Figure 9.3-8 and Figure 9.3-9.

The Compressed Air System consists of two subsystems: Plant Compressed Air System and the Containment Compressed Air System. Each subsystem employs redundant, oil-free compressors with associated filters, aftercoolers, moisture separators, air dryers, receivers and operating controls. Subsystem descriptions are presented in Subsection 9.3.1.2.

The demands on each subsystem are divided into two separate groups: (a) pneumatic instrument and control demands which require clean dry air, and (b) station service air demands which receive undried air.

Instrument and control air distribution ring headers in the Turbine Building and branch headers to other areas are supplied with dried air from two redundant instrument air headers. The supply lines to each instrument air ring header are provided with an isolation valve and a check valve. In this manner, failure of a single instrument air header will not eliminate the air supply, and should prevent unnecessary plant transients due to accidents or maintenance of the Instrument Air System.

The pneumatic devices of various systems are divided into two categories as follows:

a. Critical pneumatic devices which would directly or indirectly cause a turbine trip, reactor trip, containment isolation or equipment damage are individually fed from both instrument air loops (A and B) through separate check valves.

b. For pneumatic devices in systems where dual paths are available (e.g., backup valves in parallel or alternate paths), one set of devices is fed from loop A, and the other set from loop B.

Pneumatic devices in safety class systems are designed to fail in the safest position upon loss of air. However, in a few instances, including the ASDVs for Station Blackout (see Section 8.4.4.3), it is desirable to maintain pneumatic control for modulating valves or time is available for operator action. In these instances, high-pressure gas bottles are provided for backup to the Compressed Air System or the equipment has provisions for manual operation. For the seismic and safety classifications of the high-pressure gas bottles, pressure regulators and interconnecting tubing, refer to Table 3.2-2.

The following devices are supplied with backup air:

Device	Capacity of Supply	Component Fail Position
Emergency Feedwater Pump Turbine Steam Supply Valves	4 Complete Cycles in 10 hours	Fail Open
Atmospheric Steam Dump Valves	10 Complete Cycles in 10 hours	Fail Closed
Primary Component Cooling Temperature Control Valves	10 Complete Cycles in 6 hours	Fail Open
Primary Component Cooling Temperature Control Bypass Valves	10 Complete Cycles in 6 hours	Fail Closed

Both the Plant and Containment Air Systems are nonseismic Category I. Since the Compressed Air System operates at approximately 100 psig and at ambient temperature, it is not considered a high-energy system. Therefore, protection against pipe whip is not necessary. However, the piping is supported in accordance with Seismic Category I criteria in all areas where failure could render safety class systems or components inoperable, or compromise safe plant shutdown.

A line supplying service air from the Plant Air System is provided to the containment for post-accident combustible gas control. However, this line would only be used should both safety-related hydrogen recombiners fail. Containment isolation valves and the associated piping are Safety Class 2, seismic Category I. The Combustible Gas Control System is explained fully in Subsection 6.2.5.

A line supplying instrument air from the plant air system is provided to both containment instrument air ring headers to back up the containment compressed air system in the event both containment compressors fail. Containment isolation valves and associated piping are Safety Class 2, Seismic Category I.

In addition to special design provisions explained above, the Compressed Air System and its components are designed to the following codes and standards:

ASME Boiler and Pressure Vessel Code - Section VIII

American National Standard Institute - B31.1

ANSI MC11.1-1976 (ISA-S7.3)

IEEE Standards

Each of the elements of the Quality Standard for Instrument Air, ISA-S7.3, is addressed below:

Element 4.1 Dew Point (at line pressure)

Since part of the Plant Instrument Air System is exposed to the outdoor atmosphere, Element 4.1 of the quality standard requires that the dew point of the instrument air at line pressure be at least 18°F below the minimum outdoor temperature at the site.

Per the Service Environment Chart, Updated FSAR Figure 3.11-1, the minimum outdoor temperature at the site is (-)16.8°F; therefore, the dew point at line pressure must be no greater than (-)34.8°F. The outlet air dew point of the instrument air dryers at the instrument air header pressure is (-)40°F. Containment instrument air dew point will be maintained less than 18°F below Containment ambient temperature in all modes.

Element 4.2 Particle Size

Element 4.2 of the quality standard requires that the maximum entrained particle size at the instrument be three microns. The dual filters located in each IA subheader and the filter/regulators located just upstream of each user (as supplied by the user manufacturer) both provide approximately 40-micron filtration (for both the plant and containment IA systems).

The manufacturers of the pneumatic instruments and valve actuators have determined that operation of their equipment using 40-micron filtration devices does not cause damage which affects performance. Therefore, these manufacturers supply 40-micron filter/regulators as standard accessories. These filter/regulators along with the system filters provide redundant means for removal of particles. Additional filtering has been provided when it has been determined that smaller micron **filtering** is required.

Element 4.3 Oil Content

Element 4.3 of the quality standard requires that the maximum condensible hydrocarbon content of the instrument air (under normal operating conditions) not exceed 1 ppm either on a weight basis or on a volume basis.

The compressors are oil-free (there is not infiltration of lubricating oil), as are the dryers.

Compressed air can also be supplied to the system via a permanent connection using a portable compressor. The portable compressor may not be an oil-free compressor. However, air supplied from this compressor meets the requirements of ISO 8573-1, Class 1.7.1 (oil content <0.01 mg/m^3).

Element 4.4 Contaminants

The quality standard requires that the instrument air be free of corrosive or otherwise hazardous contaminants. The two instrument air systems (plant and containment) are fed compressed air from the Turbine Building and the Containment. There should be no detrimental gaseous contamination in these intake areas. Particulate contamination, should it become entrained in the air stream, would be removed by the filter in the system. Procedures incorporate periodic sampling (at least once per year) of the instrument air quality.

9.3.1.2 System Description

a. Plant Compressed Air Subsystems

The plant compressed air subsystem consists of three compressors, intake filters, aftercooler/moisture separators, four air receivers, two instrument air dryers, associated instruments/controls, piping and valves. The above equipment is located in the south end of the Turbine Building.

Two compressors are of the air-cooled, rotary screw oil-free type. Each compressor is furnished with an air filter (dry type) at its intake and an after cooler/moisture separator on its discharge side. The compressors are piped in parallel, discharging into two air receivers. Each receiver outlet branches into two discharge lines. One line from each receiver is connected to a common header supplying service air to the entire unit. The other discharge line is connected to its own air drying system, which supplies one of the two redundant instrument air headers.

To insure a continuous supply of air for the dryers which supply the instruments and controls, air pressure is monitored. Low pressure isolates each receiver from the other and the service air header, thus preventing the service air system from bleeding down the instrument air supply, and increasing the independence of the two instrument air loops.

The third compressor is also an air cooled, rotary screw oil-free type. It is furnished with an inlet air filter, an integral air-cooled intercooler and aftercooler with moisture separators and a self-contained lube oil subsystem. The compressor is aligned to discharge into two auxiliary air receivers and ultimately connects into the air compressor piping downstream of the main air receivers. This air compressor is powered from a nonsafety-related 480V bus which is not connected to the Emergency Diesel Generators. This compressor is not, therefore, available following a loss of offsite power.

All components such as compressors, receivers, filters and air dryers are piped and valved so they may be serviced or removed from operation without interrupting the normal air supply.

Two of the rotary screw plant air compressors are connected to the emergency diesel-generator buses, making them available following a loss of offsite power.

b. Containment Compressed Air Subsystem

This subsystem is the source of compressed air for all the pneumatic instruments, controls and general service requirements in the Containment Building. The Compressed Air System for the Containment Building is shown in Figure 9.3-5. The subsystem consists of two packaged compressor units (including intake filter, aftercooler/moisture separator, receiver), two instrument air dryers, instrument/controls, piping and valves, all located in the Containment Building. Each compressor unit discharges air to an independent air dryer. From the dryer it is piped to air ring headers, which supply dry air to each pneumatic instrument or control. Shut-off and check valves are installed in each supply line to the ring headers for isolation. The branch line from a ring header to each pneumatic device includes a valve for isolation.

All components are piped and valved so they may be serviced or removed from operation without interrupting the air supply.

The Containment Compressed Air System is powered from nonsafety-related motor control centers. The containment compressors are connected to the emergency diesel-generator buses, making them available following a loss of offsite power.

Cooling water to the containment air compressors is supplied by the Primary Component Cooling Water (PCCW) System (see Subsection 9.2.2).

9.3.1.3 Safety Evaluation

The Compressed Air Supply and Distribution System is a nonsafety class system which receives special design treatment. Piping is supported in accordance with seismic Category I criteria in all areas where a failure could render safety class systems or components inoperable, or compromise safe plant shutdown.

Safety Class 3 accumulator systems are provided for certain pneumatic components for which continued pneumatic control is desired upon loss of the Compressed Air Systems. Although these components will eventually fail in the safest position as the accumulators bleed down, sufficient time is provided by the accumulators so that immediate operator action is not required (see Subsection 9.3.1.1).

There are no safety-related components in the containment which require air to perform a safety function. Pneumatically-operated valves, such as inboard containment isolation valves, fail in the safe position. To assure the valves fail in their safe position, all tubing and flexible connectors in the vent path from safety-related pneumatic devices to Class 1E solenoids are seismic Category I.

9.3.1.4 Tests and Inspections

All components of the Compressed Air System are shop tested and inspected prior to their shipment. After installation, the system is inspected and tested to verify its performance.

9.3.1.5 Instrumentation

The Plant Compressed Air System is designed to operate automatically. Two separate pressure setpoints (high and low) will be allotted to the three rotary screw compressors of the system during normal operation for loading and/or starting purposes.

To ensure continued availability in the event of loss of offsite power, two of the three rotary screw compressors are powered from the redundant diesel generator buses A and B, and are automatically started following a loss of offsite power.

Normally, the Compressed Air System provides for both service air and instrument air requirements. One service air header and two redundant instrument air headers (loop A and loop B) are connected to the system. Pressures of each of the three headers are individually monitored in the main control room, with low pressure alarm. If the common air pressure of the system drops below a pre-determined setpoint, the service air header will be automatically isolated from the air system, so that the complete capacity of the system will be available for instrument air requirements. Service air isolation is alarmed at the MCB.

Pressure and moisture instruments are used to monitor the performance of the instrument air dryers. Drying/recharging of the two sections of the dryer is on a time basis, with timing based on operating experience. Any dryer malfunction is alarmed at the MCB.

The Containment Compressed Air System is designed to operate automatically. During normal operation, the two compressors feed the two redundant instrument air headers separately through individual air dryers. The common service air header is kept isolated from the system. The air pressure of each of the redundant instrument air headers is separately monitored at the MCB, with low pressure alarmed.

9.3.2 Process Sampling System

9.3.2.1 Design Bases

The sample system provides representative liquid and gas samples for chemical and radio-chemical laboratory analysis of the water chemistry of the Reactor Coolant System, steam generator blowdown, Secondary Steam and Water Systems and other auxiliary systems under normal operating conditions. The sample system also provides the capability to obtain gas samples of the containment atmosphere and liquid samples from the reactor coolant loops, and containment recirculation sumps under post-accident operation. Table 9.3-1 lists possible sources and various analyses which may be performed to assess the chemistry conditions of the plant. The table also includes the types of samples, purpose, and application of the samples for this assessment. Appropriate chemistry specifications are provided in the respective system's UFSAR chapter.

The seismic and quality group classifications of sample lines and components conform to the classification of the system to which each sampling line and component is connected. Where appropriate, classification to a lower seismic and/or quality group is justified on the basis that adequate isolation valving or flow restriction is provided. Sample lines penetrating the containment are provided with Engineered Safety Features Actuation System (ESFAS) isolation valves. Containment isolation and valve descriptions are discussed in Subsection 6.2.4.

Heat exchangers, vessels, piping, fitting and valves are designed, procured and installed in accordance with ASME Boiler and Pressure Vessel Code, Sections III, VIII, and ANSI B31.1. Safety class description of the various components are indicated on the system P&IDs (see Figure 9.3-10, Figure 9.3-11, Figure 9.3-12 and Figure 9.3-13 for the reactor coolant, steam generator and other auxiliary systems sampling subsystems). The components of the secondary steam and water sampling and the post-accident sampling subsystems are nonnuclear safety class (NNS).

Flow in the reactor coolant and steam generator blowdown sample lines is turbulent during purging or sampling, to ensure that any particles remain suspended. The reactor coolant sample lines are provided with a purge path to the Chemical and Volume Control System (CVCS) or Boron Recovery Systems (BRS). Purging of the lines prior to collecting the sample is required. Gaseous flow from the chemical and volume control tank (CVCT) and pressurizer relief tank (PRT) sample lines is directed through sample vessels and discharged to the Equipment Vent System. The sample lines from the residual heat removal (RHR) and Demineralized Water Systems (DWS) are directed to the sample sink for "grab" samples, and are purged by allowing the fluid to drain to the sink prior to taking the sample.

The sampling system is designed to direct the reactor coolant sample purge fluids to the chemical and volume control tank or either the primary drain tank or the sample sink, if the chemical and volume control tank is not available. Purge flows and sample overflows from the steam generator blowdown and other auxiliary systems sampling subsystems are normally directed to the Radioactive Liquid Waste System via the floor and equipment drains.

The Post-Accident Sample System is designed so that the flow through the sample lines is turbulent in order to reduce plate out. In addition, these lines can be flushed with demineralized water after a sample is taken. The Post-Accident Sample System also allows for collection of an adequate volume of fluid which results from purging the sample lines in order to obtain representative samples. Provisions exist which enable samples to be returned to the containment, even if pressurized.

The steam generator blowdown sampling is continuous, and provides radiation, cation conductivity and sodium ion monitoring of each blowdown line. See Subsection 9.3.2.5 for discussion of steam generator blowdown high radiation signals.

The secondary steam and water sampling is, in general, continuous, and serves to monitor additive levels and contaminant levels as an aid to minimizing steam generator and turbine corrosion and fouling.

See Figure 9.3-10, Figure 9.3-11, Figure 9.3-12, Figure 9.3-13 and Figure 9.3-14 for those samples routed to central sampling points. The locations of the sample points are shown on the appropriate system piping and instrumentation diagrams for the system to be sampled. Sample points for the secondary steam and water sampling subsystem are also shown diagrammatically on Figure 9.3-15.

9.3.2.2 System Description

The sample subsystems from the reactor coolant, steam generators and other auxiliary systems provide representative gas and liquid samples for laboratory analysis, in accordance with Regulatory Guide 1.21, Positions C.6 and C.7. Typical information obtain includes: reactor coolant boron, sodium ion and halogen concentrations, fission product radioactivity level, hydrogen, oxygen, and fission gas content, corrosion product concentration, and chemical additive concentration.

The sampling subsystem for secondary steam and water systems provides representative samples for measuring specific and cation conductivity, concentrations of sodium ion, dissolved oxygen and hydrazine.

a. Subsystem Description

The system is divided into five subsystems: reactor coolant sampling, system generator blowdown sampling, auxiliary system sampling, secondary steam and water sampling and post-accident sampling.

1. Reactor Coolant Sampling Subsystem

Reactor coolant is sampled at four locations in the Reactor Coolant System. Liquid samples are taken from the pressurizer liquid space and reactor coolant loops 1 and 3. The remaining sample is a steam sample and is taken from the pressurizer steam space. Provisions exist to enable sampling of reactor coolant loops 1 and 3 under post-accident conditions.

Each of the four reactor coolant system sample lines inside the containment are equipped with automatic ESFAS isolation valves. The pressurizer steam and liquid sample lines are joined together in a common header before leaving the containment. This common line is provided with an automatic exterior containment isolation valve. The sample lines from reactor coolant loops 1 and 3 are also provided with automatic exterior containment isolation valves. The sample line connections to the reactor coolant loops are sized to meet the small leak analysis of Subsection 15.6.2.

Each reactor coolant loop sample has a manual flow valve to limit the flow to less than 373 lb./hr. The length of each reactor coolant loop sample line inside containment is sufficient to permit decay of short-lived radionuclides. The length of these lines is adequate to provide a minimum 45-second delay within containment. This 45-second delay time allows the short-lived isotopes, primarily N-16 (7.4 second half-life) to decay sufficiently to minimize the hazard to personnel. The pressurizer is a relatively stagnant volume and the effective half-life is great enough to decay the N-16.

Additional shielding is provided, where necessary, to reduce potential personnel exposure, as described in Section 12.3.

Each pressurizer sample line has a capillary tube to limit the flow to less than 373 lb./hr (0.75 gpm sample rate) with all valves in the line fully open. The sample line from the pressurizer steam space is equipped with two in parallel capillary tubes, one of which is normally isolated. The capillary tube permits a small flow of 50 lb./hr to be purged constantly or intermittently from the pressurizer steam space to the volume control tank, thus removing noncondensible gases. The use of two capillary tubes on the pressurizer steam space sample line allows continuous venting of the pressurizer in the event of tube blockage.

Sample heat exchangers are provided in the common pressurizer steam and liquid space sample line and in the common line from reactor coolant loops 1 and 3. These sample heat exchangers are sized to cool the sample to 95°F. Flow is controlled in either line by adjusting the pressure reduction or the block valve in the respective line, and is then routed to the sample sink for grab samples. For operator safety, these lines are double-valved at the sink. Overpressurization of these heat exchangers is controlled administratively by assuring that either the valve upstream or downstream is left open. This prevents fluid from being isolated in these lines. The heat exchangers are also protected by a relief valve on the cooling water outlet.

Sample vessels are provided for obtaining volume control tank or letdown degasifier samples, and a pressurizer relief tank gas sample. These vessels are made of austenitic stainless steel and are equipped with quick-disconnect couplings with integral or built-in poppet-type check valves and integral isolation valves at the sample sink. Additionally, an in-line septum may be used in place of the sample vessels.

2. Steam Generator Blowdown Sampling Subsystem

The flow path for each sample is typical; therefore, only one path is discussed. The steam generator blowdown (SGBD) is sampled downstream of the containment isolation valves and upstream of the blowdown system pressure-reducing valves. See Subsection 10.4.8 for discussion of blowdown isolation.

Each sample heat exchanger reduces the sample temperature to 109°F at 373 lb./hr flow rate. The flow is then routed through a flow regulating valve which reduces pressure to 50 psig. All instrumentation is located downstream of this valve. The radiation instrumentation provides continuous monitoring when steam generator blowdown is in service.

The instrumentation is protected against overpressurization by a relief valve venting to a floor drain in the Primary Auxiliary Building. Venting could occur from closure of a downstream block valve. The blowdown sampling lines are routed to the sample sink for grab samples.

The sample sink is stainless steel with a raised edge to contain splashed liquid. The sink drains via a floor drain to the Waste Disposal System. TMOD 04-001 provides the capability to normally divert the steam generator sink drains to the steam blowdown waste holdup sump (WHUS) to avoid excess radioactive waste generation. Demineralized water is supplied to the sink.

3. Auxiliary Systems Sampling Subsystem

This subsystem consists of sampling lines which run from the Plant Auxiliary System to the sample sink or local component sample stations.

The sampling lines from the Chemical and Volume Control and Residual Heat Removal Systems to the sink are provided with double-valving at the sink. These lines also have bypass connections to the chemical and volume control tank and primary drain tank through the reactor coolant sampling line discharge. The following auxiliary system sample taps are provided at the sample sink:

Type Sample	System	Origin
Grab	Chemical and Volume Control System	Letdown Heat Exchange
Grab	Chemical and Volume Control System	Cation and Mixed Bed Demineralized
Grab	Chemical and Volume Control System	Letdown Degasifier Trim Cooler
Grab	Chemical and Volume Control System	Thermal Regeneration Demineralizer
Grab	Residual Heat Removal	Residual Heat Removal Heat Exchanger
Grab	Demineralized Water	Demineralizer
Sample Vessel	Chemical and Volume Control System	Chemical and Volume Control Tank
Sample Vessel	Chemical and Volume Control System	Letdown Degasifier

Local sample points of other auxiliary systems are shown in the figures of their respective Updated FSAR sections, as listed below:

Sample Source	Updated FSAR Section
Refueling Water Storage Tank	6.2.2
Accumulators	6.3.2
Boric Acid Tank	9.3.4
Boric Acid Batching Tank	9.3.4
Primary Drain Tank Degasifier	9.3.5
Chemical Mixing Tank	9.3.4
Spent Fuel Pool	9.1.3
Containment Sumps	9.3.3
Containment Atmosphere	6.2.5
Condensate and Feedwater	10.4.7
Steam Generator Blowdown/ Demineralization System	10.4.8
Gas Waste System	11.3.2
Release Recovery Tanks	9.3.5, 9.3.4

Other sample points are given in Table 11.5-3

4. Secondary Steam and Water Sampling Subsystem (SSW)

The SSW subsystem monitors the quality of steam and water at designated sample points, as shown if Figure 9.3-15. Sampling, in general, is done on a continuous basis, with the additional capability of grab sampling for laboratory analysis. Each sample is representative, with properly designed sampling nozzles used wherever required. To preclude interference by foreign material (e.g., rust, scale, dirt, etc.), a routine sample purge is performed prior to bringing a sample in line.

For proper analyzer operation and safety, the pressure of each sample is reduced at the sample panel and, if required, the sample is adequately cooled.

Deviations of measured quantities from specified values are alarmed at a local panel in the Turbine Building.

In the event of leakage of reactor coolant into the secondary system, radioactivity may be present in the SSW samples. A radiation alarm from the steam generator blowdown sampling subsystem radiation monitors alerts personnel to potential primary to secondary leak conditions.

5. Post-Accident Sampling Subsystem

The post-accident sampling subsystem provides the capability to obtain liquid samples from reactor coolant loops 1 and 3, the containment recirculation sumps, and gas samples of the containment atmosphere under post-accident conditions.

The reactor coolant sampling line used during post-accident operation branches off the common line from loops 1 and 3 inside the Primary Auxiliary Building. This line bypasses the sample heat exchangers and runs through the post-accident sample heat exchanger and onto the post-accident sample panel.

The configuration of the containment isolation valves on the sample lines from the reactor coolant loops 1 and 3 and the power supply arrangement to these valves ensure that a reactor coolant sample can be obtained in the event of a power train failure.

The valving on the post-accident sample panel is operable through a shield wall behind which the panel is mounted. The post-accident sample system heat exchanger cools the sample being taken with PCCW from Train A. After a sample has been collected, the sample panel can be flushed with demineralized water which is retained in a flush tank before being returned to the containment. This return line is provided with automatic ESFAS isolation valves. Gases from the flush tank and the sample panel are routed to the Primary Auxiliary Building vent system for cleanup.

Samples from the containment recirculation sumps are taken from the discharge lines of the residual heat removal pumps RH-P-8A and RH-P-8B, which draw through valves CBS-V8 and CBS-V14. In order to sample either of the two sumps, each sample line is provided with a remotely operated diaphragm valve before joining together in a common header leading to the post-accident sample panel.

Gas samples of the containment atmosphere are obtained by bypassing the flow to the hydrogen analyzers through sample vessels, which are equipped with quick-disconnect couplings with integral or built-in poppet-type check valves and integral isolation valves. Once a sample is taken, the sample vessel is removed and its contents are analyzed for hydrogen content and gamma spectrum.

Solenoid valves whose operation is required to perform post-accident sampling are powered from an emergency backup power source.

b. Equipment Location and Description

The system equipment is situated at five locations:

1. The sample heat exchangers, sample sink, sample panel, post-accident sample panel, flow control valves, reach rod-operated valves and local flow, temperature and pressure indicators for the reactor coolant, post-accident and other auxiliary systems sampling subsystems are located on the grade level of the Primary Auxiliary Building.

2. The steam generator blowdown sample panel and grab sample are located on a raised platform on the west side of the sample heat exchanger room.

3. The capillary tubes on the pressurizer steam and liquid space sample lines are located inside the missile barrier in containment.

4. The sample vessels for containment atmosphere are located on grade level in the hydrogen analyzer area of the main steam and feedwater pipe chase on the east side of containment.

5. The secondary steam and water sampling subsystem equipment and components are located in the Turbine Building.

   The equipment design parameters for the reactor coolant, steam generator blowdown, post-accident sampling and other auxiliary systems sampling subsystems are summarized in Table 9.3-2.

9.3.2.3 Safety Evaluation

The sample system has no emergency or safety function, nor is its performance required to prevent an emergency condition.
Isolation of those samples originating within the containment is accomplished by:

a. Manual valves near the sample points

b. Electrically operated solenoid valves which automatically close on a containment isolation signal, or can be closed by remote manual switches on the main control board

c. Manual valves at the sample sinks.

9.3.2.4 Tests and Inspections

The system is operationally tested and samples drawn including appropriate purging from each sample point.

9.3.2.5 Instrumentation and Control

Local instrumentation for monitoring pressures, temperatures, and flows is provided in the sample sink area and at the sample panel in the Turbine Building to provide for safe manual operation and to verify sample flows.

The four steam generator blowdown sample lines are continuously monitored for radioactivity. If a high radioactive level is detected, alarms are triggered on the local panel, the RDMS computer and in the control room. In addition, the blowdown flash tank discharge line is automatically isolated if the alarm setpoint on RM6519, or any of the individual blowdown monitors is exceeded.

Administrative overrides allow blowdown flow to continue after isolation of the system, for evaporation processing and/or sampling on an individual line basis. See Subsection 10.4.8 for additional information on blowdown system operation.

The steam generator blowdown portion of the system also contains cation conductivity and sodium process instruments to monitor for condenser leakage. Each steam generator blowdown line is monitored separately. A high conductivity and high sodium sample is alarmed at the sample control panel and at the main control board.

Sample system lines penetrating the containment have appropriate containment isolation valves which automatically close on a "T" (Phase A containment isolation) signal and also fail closed. These valves, being safety-related, are also controlled from the main control board. See Section 7.3 and Subsection 6.2.4 for additional information on containment isolation.

Globe-type valves are used for interior containment isolation. The interior and exterior isolation valves are equipped with operators for automatic or remote operation. The valves are actuated by a containment isolation signal or manually from the control room. See Subsection 6.2.4 for the types of operators used and discussion of containment isolation signal.

Measured quantities from the secondary steam and water sampling subsystems are indicated and/or recorded at local panels in the Turbine Building.

9.3.3 Equipment and Floor Drainage System

This system includes tanks, sumps, pumps, piping and instrumentation, as required, to collect, segregate and control liquid leakage within the radioactively contaminated portions of the plant.

9.3.3.1 Design Bases

a. The system is designed to handle all anticipated normal leakage volumes from component and liquid drain sources within the area covered by the Equipment and Floor Drainage System.

b. The system is also designed to handle all anticipated abnormal leakage from sources such as malfunctioning pump seals, leaky flange gaskets and blown valve stem packing. The maximum expected flow rate into any one sump from all expected abnormal sources is less than the 50 gpm capacity of the sumps in areas containing safety class equipment. Abnormal flows from pipe breaks are not included in the system design.

c. The areas covered by this system are designed to prevent the backup of water from within the plant or from outside.

d. Liquids are segregated with respect to their potential for reuse in the plant.

e. Pump design heads are selected to achieve full-rated pump discharge under worst case operating conditions.

f. The system is designed to achieve radiation levels in all areas that are as low as is reasonably achievable.

g. The system is designed to preclude discharge of contaminated liquids into noncontaminated systems.

h. The system is designed to remove water used for fire fighting. While the postulated fire using two fire hoses at 75 gpm each is in excess of the pumping capability of any two sumps, the resultant minor flooding will not prevent operation of the sump pumps or any equipment in the flooded area.

9.3.3.2 Description

The drainage sources, collection systems, sumps and tanks within this system are shown on piping and instrumentation drawings, Figure 9.3-16, Figure 9.3-17, Figure 9.3-18, Figure 9.3-19, Figure 9.3-20, Figure 9.3-21, Figure 9.3-22, Figure 9.3-23, Figure 9.3-24 and Figure 9.3-25. Anticipated normal leakage rates and their sources are summarized in Table 9.3-3. The component data for the Equipment and Floor Drainage System is summarized in Table 9.3-11.

a. General

1. All leakage within the areas covered by this system is assumed to be radioactively contaminated. Depending on the quality, the liquids are:

    (a) Processed for reuse in the plant.

    (b) Processed for discharge to the service water system discharge tunnel as noncontaminated waste. A radiation monitor interlocked with an isolation valve in this line prevents accidental discharge of contaminated liquids.

    (c) Processed by the Waste Solidification System for disposal as contaminated waste.

    The discharge of all pumps handling these contaminated liquids is hard-piped directly to the receiving tank or sump to prevent spillage in noncontaminated areas.

2. Where pumps are duplex-mounted, as in sumps or for the reactor coolant drain tank (RCDT), the preferred and backup pump selected is controlled manually at the Waste Management System (WMS) control panel to maintain approximately equal running time on each pump. The preferred pump starts on a high-level signal, with the backup pump starting only if the level continues to rise to the high-high level.

3. Operation and instrumentation of the various sump pumps provide a backup for indicating abnormal leakage rates. For those pumps or tanks having two pumps, the indication of progressively increasing abnormal leakage rates follows a three-step pattern:

    (a) Increasingly long running times of the preferred pump, as indicated by the pump operating hour meter

    (b) Continual running of the preferred pump, plus increasingly long running times of the backup pump

    (c) Continual running of both pumps, plus a sump/tank high-level alarm.

    The pumping rate for each sump pump and its total design head are shown in Table 9.3-4. Also shown on this table, is the sump capacity and the freeboard, which is the volume between the maximum sump design level and the top of the sump pit.

4. All entry ways into the building areas covered by this system are above the probable maximum flood level, thus preventing an external flooding situation from forcing water into the buildings covered by this system.

5. Flooding in the upper building elevations covered by this system will not cause back-flow in lower levels of the plant containing safety-related equipment, due to one or more of the following design features:

   (a) Drain pipes from lower elevations are directed into the drain header at a 45° angle. Therefore, high flow rates through the header caused by flooding in the upper levels will create a slight vacuum in the entering drain line from the educator effect, which would prevent water from backing up into the lower drain line.

   (b) Drain lines from areas with safety-related equipment are run directly to the sump without tying into drain headers from upper building levels.

   (c) Curbs are used to exclude flood waters from other areas entering areas with safety-related equipment.

6. To reduce radiation levels in the sumps, sparge lines are designed to spray a portion of the sump pump discharge downward against the sump bottom to prevent build-up of radioactive crud.

7. To reduce radiation level exposure to personnel, the floor drain piping is embedded in the concrete flooring and sloped to promote complete and rapid draining of all liquids to the sumps or tanks. Where exposed piping is used, it is located as close to the overhead as possible.

8. Where exposed drain piping runs adjacent to safety-related equipment, the drain piping is designed as seismic Category I, and is supported accordingly.

9. The tanks and other components in this system are all located in shielded cubicles or in areas seldom frequented by plant personnel. Exposed piping is similarly shielded in pipe trenches or run in unfrequented areas.

10. Identification of sources of abnormal leakage is by visual inspection, as drain lines are all open-ended or are fitted with a short section of transparent flexible tubing adjacent to the floor drain.

b. System Description (By Buildings)

1. Containment Building

There are two sumps in the Containment Building; one on the (-)26'-0" level; the other on the (-)53'-4" level in the reactor instrument pit. Each sump has two pumps, each with a rated capacity of 25 gpm. Under normal conditions, the lower sump will always be dry as there are no drains directed to it. Entry of water into the instrument pit is prevented by curbs around the two openings at the (-)26'-0" elevation. The tops of these curbs are at an elevation of (-)23'-6".

Part of the Equipment and Floor Drain System in the containment is the reactor coolant drain tank (RCDT) and its associated pumps. The reactor coolant drain tank has a 350-gallon capacity. The two RCDT pumps have a rated capacity of 100 gpm each, and are arranged for duplex operation, with manual selection of the preferred and backup pump at the WMS control panel. Pump operation is controlled both by the temperature and level of the liquid in the RCDT. High temperature starts the pump with the control valve lineup for 100 gpm pump recirculation flow through the RCDT heat exchanger and back to the RCDT. A high level in the RCDT will start the pump with a valve lineup for discharge to the primary drain tanks (PDT) in the Waste Processing Building. An interlock prevents discharge of high temperature liquid to the PDT. Each pump has a rated capacity in excess of any leakage which could be accepted from the components draining to the RCDT.

A generalized indication of the source for excessive leakage is given by the temperature sensing elements attached to the drain lines leading to the RCDT (see Figure 9.3-16, Figure 9.3-17 and Figure 9.3-18). The drain lines from the #2 RCP seal have flow-sensing elements which will provide information on excessive leakage from this source.

There are three categories of liquids encountered in the containment:

(a) Hydrogenated and recyclable - All operational leakage into the RCDT is in this category.

(b) Aerated and nonrecyclable - All liquid reaching the sumps comes under this classification.

(c) Nitrogenated and recyclable - The liquid from the pressurizer relief tank (PRT) is also pumped by the RCDT pumps to the primary drain tanks for processing and reuse.

2. Primary Auxiliary Building

The only sump in the PAB is located on the (-)26'-0" elevation. This sump has two pumps, each with a rated capacity of 25 gpm.

A pump running-time-totalizer permits checking of gradual increase of leak rate from the PCCW pumps and other inputs to the sump. Visual inspection of the pipe openings from the PCCW pumps at the floor drain funnel permits determining which of the pumps may be leaking excessively.

There are two liquid categories in the PAB portion of the drain system. The majority of the liquid is collected by the various drains throughout the building, and is classified as aerated nonrecyclable. From the drains, it flows to the one sump in the building, after which it is pumped to the floor drain tank in the Waste Processing Building.

A second liquid category is generated on the 25'-0" and 53'-0" elevations adjacent to the PCCW and diesel cooling jacket heat exchangers. Because these heat exchangers use salt water as the cooling medium, leakage and area wash-down liquid is contained by curbs and drained to the 25' elevation where it is sampled for possible radioactive contamination. If it is contaminated, it will be hosed to the WLD system. If it is not contaminated, it will exit the PAB, via a normally locked closed valve, and hosed to the discharge structure (see Figure 9.3-21, sh.1).

3. RHR/CBS Equipment Vaults

There are two sumps in these areas, both on the (-)61'-0" elevation. Each sump has two pumps.

All liquid collected in this area is classified as aerated and nonrecyclable, and is pumped directly from the sumps to the floor drain tanks in the Waste Processing Building.

4. Fuel Storage Building

There are two sumps in the Fuel Storage Building, one on the 4'-0" elevation (sump A) and one on the 10'-0" elevation (sump B). Each sump has two pumps with rated capacity of 25 gpm.

The two sumps are somewhat different in the liquid category which reaches them. Sump A receives leakage from the pumps located on the 7'-0" elevation, as well as water from area wash-down on the 7'-0", 21'-6" and 64'-0" elevations. Sump B at the 10'-0" elevation receives splash and drainage from the new fuel up-ending area.

All floor drain liquid in the building is classified as aerated and nonrecyclable, and is pumped to the floor drain tank.

5. Waste Processing Building

The Waste Processing Building has two sumps. Both are located at the (-)31′-0" elevation, each with two pumps. Due to the differing leakage volumes expected in each sump, the pumps in sump A each have a rated capacity of 50 gpm, while those in sump B are rated at 25 gpm each.

The majority of the leakage in the building is classified as aerated and nonrecyclable, and is directed to the floor drain tanks.

In a separate category is the liquid pumped to the Waste Processing Building from the chemical drain tank in the Administration and Service Building. This liquid contains chemicals and other undesirable elements from the decontamination room, the hot lab/secondary lab sink and tool wash stand drains. This liquid is segregated in the two chemical drain treatment tanks (3600 gallons each) where it can be treated by adjusting the pH prior to sending it to the Solid Waste System (SWS). The liquid, depending on its characteristics, is then pumped by the chemical drain treatment pump (30 gpm) to one of the tanks listed below for disposition:

Waste Test Tank	WL-TK-63A & B
Floor Drain Tank	WL-TK-59A & B
Waste Concentrates Tank	WS-TK-76
Waste Feed Tanks	WS-TK-198A & B
Recovery Test Tanks	BRS-TK-58A & B

A nonstandard drain is the blind sump on the truck dock. The liquid collected here contains oil and other contaminants which are segregated for testing and separate disposition.

6. Administration and Service Building RCA Walkways

There is just one sump in the Administration Building that receives drainage from all contaminated areas. The sump has a single pump installed, with rated capacity of 35 gpm.

Provisions have been made for installation of a second sump pump, should future drainage volumes require additional pumping capacity. The piping, as installed, includes provisions for the second pump. There are two sumps in the RCA walkways, each with one pump. There is no drainage to any of these sumps. Their purpose is to provide pumping capability in case of pipe leakage in the tunnel. To maintain the walkway clear of obstructions, the pumps are mounted in sumps which are 6'-8" deep, so the pump motor is beneath the sump cover plate. The sump level controls are set for an effective sump depth of 4'-0".

The 1000-gallon chemical drain tank collects drainage from all areas in the Administration Building where the quality of the drain liquids and the contaminants therein could be such to make it undesirable for handling in the Floor Drain System. Instead, the liquid is transferred by the chemical drain transfer pump (40 gpm) to the chemical drain treatment tanks in the Waste Processing Building for testing, treatment and final disposition, in a manner suitable to its characteristics.

The administration building sump is located near to the chemical drain tank. It collects liquids from the RCA shop floor drains, the RCA locker from personnel showers as well as the overflow and drain from the chemical drain tank.

There are just two liquid categories in these areas: (a) aerated nonrecyclable liquids which are collected in the sumps and pumped to the chemical drain treatment tanks due to the potential for oil or chemical contamination (b) chemical waste liquids which are collected in the chemical drain tank and then pumped to the chemical drain treatment tanks.

7. Control Building

   Of the various areas of the Control Building, only the cable spreading room has water lines present which, if failure occurred, could cause flooding. Two sources of water are present: the hot water heating system and the fire protection sprinkler system. Of the two, the sprinkler system provides the greatest source of water.

   There are two 6" diameter drains in the cable spreading room. One drain is located in the northeast corner of the area; the other in the southeast corner.

8. Emergency Feedwater Pump Building

   The Emergency Feedwater Pump Building has five 4" floor and two 2½" floor drains which lead into a 4" drain line to an oil separator. The inlet to the oil separator has a device which limits the inlet flow to 75 gpm.

9.3.3.3 Safety Evaluation

The Equipment and Floor Drainage System is operable during all normal modes of operation. The entire system is classified as NNS, nonseismic Category I, non-Class 1E, with the exception of piping runs through the containment walls, and the isolation valves for these penetrations.

Should a malfunction occur in the drainage system resulting in leakage from the drainage system (e.g., drain line leak, holdup tank overflow or rupture, pump seal leak, etc.), the fluid is collected in a local floor drain sump.

For the Emergency Feedwater Pump Building, piping failures were considered in the hot water heating, emergency feedwater and the Fire Protection Systems. The worst case break was in the 8" diameter emergency feedwater pump discharge header. Since the Emergency Feedwater System is at standby during normal plant operating conditions, the break postulated was a through-wall leakage crack, as required for moderate energy systems. Flow from the ruptured pipe, driven by the elevation head of the condensate storage tank is 80 gpm.

The maximum safe allowable flooding of the Emergency Feedwater Pump Building is 8 inches.

The three charging pump cubicles are located at Elevation 7'-0" in the PAB. The floor and equipment drains from all three cubicles connect into a common drain header (see Figure 9.3-21, sh.2). High energy line breaks in the pump discharge line and moderate energy line breaks in the pump suction line have been evaluated for the potential impact on the safe shutdown of the plant. This evaluation has assumed a blockage in the common drain header so that leakage from one cubicle could back up into the other two cubicles, i.e., resulting in flooding in all three cubicles. Blockages in the drain lines from an individual cubicle have also been evaluated.

For either a high energy or moderate energy line break in any one charging pump cubicle, there are several Chemical and Volume Control System alarms generated as a result of the break that alert the operators to the condition. These alarms allow the operators to take action either in the Control Room or locally in time to prevent the loss of all three charging pumps even assuming a random single active failure of one of the charging pumps to start.

The four column PCCW pumps at elevation 25'-0" in the PAB are not enclosed. The floor supporting the PCCW pumps has numerous drains and openings (doorways, grating, etc.) leading to the lower floor levels. Thus it is very improbable that this floor would be flooded to a depth which would make the PCCW pumps inoperable.

The following nonseismic Category I tanks are also located at discrete elevations in the PAB:

Elevation	Tank	Tag No.	Volume (gal.)
53'-0"	Blowdown Flash	SB-TK-40	650 (automatically isolated)
53'-0"	Boric Acid Batch	CS-TK-5	1500 (normally empty)
25'-0"	Chiller Surge	CS-TK-3	587
7'-0"	Degasifier	CS-SKD-32	370
			~3100 gallons, total

The small volume of liquids in the above tanks does not pose a serious flooding problem. If all of the above tanks ruptured, the flooding depth would only be approximately 0.5 inches.

There are two non-seismic Category I piping systems in the PAB that have large tanks located external to the building which are possible sources of flood water, should a line break occur. The reactor makeup water storage tank has a design capacity of 112,000 gallons, while the demineralized water tanks have a combined design capacity of 700,000 gallons. Both the RMW pumps and DM pumps have a maximum flow rate of 200 gpm. All drains in the PAB lead to Sump A at Elevation (-) 26 '- 0". In addition, there are various floor openings at all elevations of the PAB that would transport the water to this sump. Class IE redundant high level alarms are provided in the area of the sump to alert the operators to this leak. Early detection of potential flooding would occur before essential equipment is affected.

Each train of the residual heat removal, safety injection and containment building spray pumps is located inside a vault. The two vaults for Train A and B are completely isolated from each other so that flooding of one vault can not flood the other. There are no nonseismic Category I tanks located within these vaults.

Each vault is supplied by a 1" demineralized water line that is non-Category I, but is seismically supported. In the event of leakage of this seismically supported piping as a result of an earthquake, this leakage or any other leakage will be detected by nonsafety grade level sensors and alarms. Accordingly, early detection of vault flooding will occur before essential equipment is flooded.

The equipment and floor drainage piping is constructed of corrosion resistant material and of sufficient weight, so that the piping will last the life of the plant. The piping is designed to be 90 percent full at the maximum design flow rate. The line is, therefore, not under pressure and (1) cannot rupture due to internal pressure; (2) cannot create a back pressure resulting in reverse flow in tributary lines; and (3) pipe whipping action is negligible. The fluid will have a velocity of less than 8 fps in 4 inch lines, and less the 5 fps in 1½ inch lines. Thus, erosion and jet force damage would be negligible.

An analysis of the possible flooding effects in various areas due to the discharge from either two fire hoses at 75 gpm each for 20 minutes or the sprinkler system is discussed below. For the Waste Processing Building, possible overflow in the tank farm area is also discussed.

a. <u>Containment Building</u>

Since the total discharge of 150 gpm is 100 gpm in excess of the capacity of the two pumps in sump A, it would be expected that this sump would overflow and the excess would collect on the containment floor. This amounts to an approximate maximum depth of water of less than 1 inch. With the two pumps in sump A in operation, the accumulated excess would be removed from the containment in less than 40 minutes.

b. <u>Primary Auxiliary Building</u>

The resulting 2000 gallon accumulation of water in the sump pump area would create a maximum water depth of 6½ inches which is insufficient to reach the sump pump motors. A metal partition to the containment penetration area will prevent the excess water from the sump pump floor level running over to the (-)34'-6" level of the penetration area and into RHR/CBS vault.

c. <u>RHR/CBS Equipment Vaults</u>

The discharge of two fire hoses represents an excess volume of 2,000-gallons, more than can be pumped out by the two sump pumps. This volume would create an approximate 4 inch depth of water at the (-)61′-0" elevation. This will not reach either the sump pump motors or the safety class pumps mounted on that level.

d. Fuel Storage Building

The discharge would flood the area at elevation 4'-0" to a depth of 21½ inches, which is lower than the 7'-0" elevation. Thus, the 2000-gallon accumulation would not flood the area at the 7'-0" elevation which has the safety class spent fuel pool pumps and heat exchangers. The 21½ inch depth of water would cover the pump support stand and about one half the drive motor. Since all sump pump motors have TEFC enclosures, it is expected that the motors would continue operating for the time required to pump the sump down to normal levels.

e. Waste Processing Building

The four pumps in the two sumps have a combined pumping rate of 150 gpm, so no flooding of the sump area would occur.

Flooding accidents could occur in the tank farm area or any of the diked areas surrounding the large capacity tanks. In all cases, the drain lines from these areas lead to one of the sumps in the Waste Processing Building via locked-closed valves. Inadvertent flooding of the sump areas is thus prevented. The most likely accident of this type is overfilling of one of the tanks, with resultant overflow. All tanks have high level alarms which warn of the possibility of an overflow condition. In addition, there are dike hi-level computer alarms (VAS) for these areas.

In the floor drain tanks, the high level alarm at the main control panel serves to alert the operators on reduced capability of the system to handle leakage. It should be noted that with an overflowing floor drain tank, the overflow goes to the sump and is then pumped back to the floor drain tank. Because of this, the existence of an overflowing floor drain tank can represent a major problem. In the absence of an empty or only partially filled second floor drain tank, discharge points for floor drain tank liquid are the recovery and waste liquid evaporators. These each have a liquid process rate of approximately 25 gpm. The boron waste storage tanks (BWST) are also available for storage of floor drain tank liquid prior to processing.

f. Administration and Service Building RCA Walkways

The hose discharge is in excess of the capability of either the sump pump or the chemical drain tank transfer pump, and would cause some flooding of the sump area of the building. However, there is no safety class or plant operational components in the area so a flooding accident would not affect plant operation.

g. Control Building

The Cable Spreading Room (CSR) on Elevation 50' – 0" of the Control Building is protected by a five zone water suppression system. Only one zone would actuate at any one time due to the cross-zoned design feature requiring two diverse detectors to be in alarm in order to actuate a single zone. The largest zone is assumed to actuate at 1139 gpm, and is secured in 30-minutes by the responding fire brigade. This results in a water level of approximately 6-inches in the CSR. This is based on conservatively assuming that no water leaks through the openings around the three doors providing access to the area, or through either of the two 6-inch floor drains provided. The CSR only contains electrical cable. No equipment subject to water damage is located in this area. The floor and penetration seals through the floor are designed to be watertight to protect the electrical equipment below in the Essential Switchgear Rooms. Therefore, there is no flooding of essential equipment located in the Control Building due to this postulated fire suppression actuation.

9.3.3.4 Tests and Inspections

Sump pumps and their level switches are tested for their response to specified start and stop levels. All additional level instrumentation is functionally tested.
Periodic testing consists of the following checks:

a. Drain lines from tank farm and diked areas not blocked

b. Locked-closed valves from the tank area drains are verified locked-closed.

9.3.3.5 Instrumentation Application

a. Dual Sump Pumps

Starting and stopping of the preferred pump is performed by level switches at the sumps, which keep the pump running within a preset level range. The operator can start each pump locally and from the WMS control panel by overriding the level interlocks. Cumulative running time indicators aid the operator in pump duty rotation and provide data on leakage into the sumps. Sump high and low level alarm is provided at the waste management system control panel, the latter being actuated when sump level is low and any one pump is running. This arrangement eliminates the actuation of an alarm when the sump is dry and pump is not running.

b. Single Sump Pumps

These pumps are controlled from the waste management system control panel in the WPB. Starting and stopping each pump is automatically done by sump level switches.

The operator can override level interlocks and run the pump locally and from the control panel. Sump low and high level is alarmed at the WMS control panel. The low level alarm is actuated when the sump has a low level and the pump is running. Cumulative running time indicators on the administration building sump provide data on leakage into the sump.

c. Reactor Coolant Drain Tank Pumps

The reactor coolant drain tank (RCDT) pumps are controlled from the WMS control panel. Each pump has a cumulative running time indicator to aid the operator for pump duty rotation. Starting and stopping of the preferred pump is automatically initiated by changes in temperature and level in the RCDT. The standby pump kicks in automatically on high high level in RCDT and stops automatically on low level.

The pump discharge pressure is indicated locally, and common suction and discharge header pressure is indicated at the WMS control panel.

d. RCDT Drain Valve

This valve is manually controlled from the WMS control panel. It is kept open during normal plant operation, and closed during reactor shutdown to permit transfer of accumulator and loop drains to the PDT in the BRS system. On loss of air or power, this valve fails open.

e. RCDT Transfer Valve

This valve is controlled from the WMS control panel. During normal plant operation, the valve opens automatically when RCDT temperature is below a particular setpoint and level is above a particular setpoint. The valve closes automatically on high temperature or low level in the RCDT.

During reactor shutdown, this valve is manually opened to transfer reactor coolant loop and accumulator drains to the primary drain tank in the Boron Recovery System. On loss of air or power, this valve fails closed.

f. RCDT Recirculation Valve

The operation of this valve is slaved to that of the transfer valve. The recirculation valve opens when the transfer valve closes and closes when the transfer valve opens. On loss of air or power, this valve fails open.

g. Containment Isolation Valves

These valves are controlled from the MCB and are kept open during normal plant operation and close automatically on a "T" signal. On loss of air or power, these valves fail closed. The inboard valves are powered by Train B and the outboard by Train A.

h. RCDT and Miscellaneous Instrumentation

Influent drain lines are monitored for temperature. High temperature is alarmed at the WMS control panel and at the MCB. Tank temperature and level is displayed at WMS control panel, and high temperature and pressure is alarmed at the same panel.

i. Chemical Drain Tank

Temperature and level indication of this tank is provided at the WMS control panel.

j. Chemical Drain Transfer Pump

This pump is controlled from the WMS control panel. In normal operation, the pump starts and stops automatically on high and low level respectively in the chemical drain tank. Additionally, the chemical drain transfer pump is tripped automatically on high level in either one of the chemical drain treatment tanks to prevent overflowing of these tanks.

k. Chemical Drain Treatment Tanks

Level and temperature indication of these tanks is provided at the WMS control panel.

l. Chemical Drain Treatment Pump

The starting of the pump is always manually initiated. The pump stops automatically on low level. Appropriate level interlocks from auxiliary control valves insure that the pump is properly aligned to the receiving tanks one at a time as the other tanks are kept isolated.

m. Chemical Drain Treatment Auxiliary Control Valves

These control valves are operated from the WMS control panel, and are required to align or isolate different components of the chemical drain treatment subsystem during recirculation and transfer phases.

n. PAB Sump Pumps

For the WLD system sump in the PAB, the pumps are prevented from operating in the event of actuation of the Deluge Sprinkler System. This is to prevent large amounts of nonwaste water from being pumped into the FDT. After the deluge system is returned to normal and accumulated water is pumped out by portable pumps, the sump pump deluge actuation signal must be manually reset so that they do automatically restart.

9.3.4 Chemical and Volume Control System

The Chemical and Volume Control System (CVCS), shown in Figure 9.3-26, Figure 9.3-27, Figure 9.3-28, Figure 9.3-29, Figure 9.3-30, Figure 9.3-31 and Figure 9.3-32, is designed to provide the following services to the Reactor Coolant System (RCS):

a. Maintenance of programmed water level in the pressurizer, i.e., maintain required water inventory in the RCS

b. Maintenance of seal-water injection flow to the reactor coolant pumps

c. Control of reactor coolant water chemistry conditions, activity level, soluble chemical neutron absorber concentration and makeup

d. Emergency core cooling (part of the system is shared with the Emergency Core Cooling System)

e. Provide means for filling, draining and pressure testing of the RCS.

9.3.4.1 Design Bases

The CVCS is designed to:

a. Regulate 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 poisons, buildup of fission products in the fuel, and xenon transients.

b. Maintain 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.

c. Remove fission and activation products, in ionic form, in gaseous form or as particulates, from the reactor coolant during operation and to reduce activity releases due to leaks.

d. Add chemicals to the RCS to 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.

e. Supply filtered water to each reactor coolant pump seal, as required by the reactor coolant pump design.

f. Supply water at the maximum test pressure specified for hydrostatic testing of the RCS.

Makeup systems are not required during Station Blackout conditions because reactor coolant inventory loss should not result in the core's becoming uncovered during the four-hour coping duration (see Section 8.4.4.6). The analysis included loss or leakage of reactor coolant inventory through the reactor coolant pump seals, the sources described in the Technical Specifications and the letdown line.

9.3.4.2 System Description

The CVCS is shown in Figure 9.3-26, Figure 9.3-27, Figure 9.3-28, Figure 9.3-29, Figure 9.3-30, Figure 9.3-31 and Figure 9.3-32, with system design parameters listed in Table 9.3-5. 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.

a. 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 proper adjustment of one of the high pressure letdown valves in the letdown flow path.

Two high-pressure letdown valves are provided in parallel, either of which can be utilized to adjust letdown flow from 0 to 80 gpm.

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 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 high pressure letdown control valve. During normal operation, failed fuel detection is provided by the reactor coolant letdown gross activity radiation monitor located adjacent to the letdown line, prior to the letdown heat exchanger. For a further discussion, refer to Section 11.5, Process and Effluent Radiological Monitoring and Sampling System. The coolant then flows through the tube side of the letdown heat exchanger where its temperature is further reduced to the operating temperature of the mixed bed demineralizers. Downstream of the letdown heat exchanger, a second pressure reduction occurs. This second pressure reduction is accomplished with the low pressure letdown valve, which maintains upstream pressure and thus prevents flashing downstream of the high pressure letdown valves. The coolant then flows through the demineralizer pre-filter and through one or both of the mixed bed demineralizers.

Three charging pumps (one positive displacement, and two centrifugal) are provided to take suction from the volume control tank and return the purified reactor coolant to the RCS. Normal charging flow is handled by one of the three charging pumps. This charging flow splits into two paths. The bulk of the charging flow is pumped back to the RCS cold leg through the tube side of the regenerative heat exchanger. The letdown flow in the shell side of the regenerative heat exchanger raises the charging flow to a temperature approaching the reactor coolant temperature. Two redundant charging paths are provided from a point downstream of the regenerative heat exchanger. Either path may be used, and service may be alternated between the two to decrease the transients experienced. Also, a flow path is provided from the regenerative heat exchanger 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 the pressurizer near the end of the plant cooldown when the reactor coolant pumps, which normally provide the driving head for the pressurizer spray, are not operating.

A portion of the charging flow is directed to the reactor coolant pumps (nominally 8 gpm per pump) through a seal water injection filter. The flow is directed to a point above the pump shaft bearing. Here the flow splits and a portion (nominally 5 gpm per pump) enters the RCS through the labyrinth seals and thermal barrier. The remainder of the flow is directed upward along the pump shaft to the number 1 seal leakoff. The number 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 heat exchanger to the suction side of the charging pumps, or by alternate path to the volume control tank. A very small portion of the seal flow leaks through to the number 2 seal. A number 3 seal provides a final barrier to leakage of reactor coolant to the containment atmosphere. The number 2 leakoff flow is discharged to the reactor coolant drain tank in the Liquid Waste Processing System. The number 3 seal leakoff flow is discharged to the containment sump (this leakoff flow consists of a portion of the reactor makeup water which is injected into the number 3 seal).

The excess letdown path is provided as an alternate letdown path from the RCS in the event that 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 heat exchanger, where it is cooled by primary component cooling water. Downstream of the heat exchanger, a remote-manual control valve controls the excess letdown flow. The flow normally joins the number 1 seal discharge manifold and passes through the seal water return filter and heat exchanger to the suction side of the charging pumps (this flow can also be directed to the volume control tank via a spray nozzle).

The excess letdown flow can also be directed to the reactor coolant drain tank. When the normal letdown line is not available, the purification path is also not in operation. Therefore, this alternate condition would allow continued power operation for a limited period of time, dependent of 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 coolant expansion as a result of the RCS temperature increase.

b. Reactor Coolant Purification and Chemistry Control System

Reactor coolant water chemistry specifications are described in the EPRI PWR Primary Water Chemistry Guidelines, and implemented in the Chemistry Manual.

1. pH Control

The pH control chemical employed is lithium hydroxide. The concentration of lithium-7 in the RCS is maintained in the range specified for pH control per approved station procedures and EPRI PWR Primary Water Chemistry Guidelines. If the concentration exceeds this range, the cation bed demineralizer is employed in the letdown line in series operation with one or both of the mixed bed demineralizers. Since the amount of lithium to be removed is small, and 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 via the charging flow. The solution is prepared and poured into the chemical mixing tank. Reactor makeup water is then used to flush the solution to the suction manifold of the charging pumps.

2. Oxygen Control

During reactor startup from the cold condition, hydrazine is employed as an oxygen scavenging agent. The hydrazine solution is introduced into the RCS in the same manner as described above for the pH control 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. A sufficient partial pressure of hydrogen is maintained in the volume control tank so that the specified equilibrium concentration of hydrogen is maintained in the reactor coolant. A pressure control valve maintains a minimum pressure in the vapor space of the volume control tank. This valve can be adjusted to provide the correct equilibrium hydrogen concentration. Hydrogen is supplied from the hydrogen manifold in the Gaseous Waste Processing System. When the letdown flow is degasified, hydrogen is injected into the degasified coolant before it is discharged into the volume control tank.

3. Reactor Coolant Purification

Mixed bed demineralizers and a degasifier package are provided in the letdown line to provide cleanup of the letdown flow. The demineralizers remove ionic corrosion products and certain fission products. One demineralizer is in continuous service, with the second mixed bed demineralizer serving as a standby unit for use if the operating demineralizer becomes exhausted during operation or both demineralizers are in service operating in parallel.

A further cleanup feature is provided for use during cold shutdown and residual heat removal. A remote-operated valve admits a bypass flow from the Residual Heat Removal System (RHRS) into the letdown line upstream of the letdown heat exchanger. The flow passes through the heat exchanger, though the demineralizer pre-filter, through a mixed bed demineralizer and the reactor coolant filter to either the volume control tank and to the RCS via the normal charging route, or directly to the operating RHR pump suction line.

Filters are provided at various locations to ensure filtration of particulate and resin fines, and to protect the seals on the reactor coolant pumps.

Fission gases are normally removed from the reactor coolant by the letdown degasifier, or they may be removed by continuous purging of the volume control tank to the Gaseous Waste Processing System.

c. Reactor Makeup Control System

The soluble neutron absorber (boric acid) concentration is controlled by the Reactor Makeup Control System. It can also be controlled by the Boron Thermal Regeneration System. The Reactor Makeup Control System 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 pump.

The Reactor Makeup Control System provides a manually preselected makeup composition to the charging pump suction header or to the volume control tank. The makeup control functions are those of maintaining desired operating fluid inventory in the volume control tank and adjusting reactor coolant boron concentration for reactivity control. Reactor makeup water and boric acid solution are blended together at the reactor coolant boron concentration for use as makeup to maintain volume control tank inventory, or they can be used separately to change the reactor coolant boron concentration.

The boric acid is stored in two boric acid tanks. Two boric acid transfer pumps are provided, with one pump normally aligned to provided 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 is also used to recirculate the boric acid tank fluid.

All portions of the CVCS which normally contain concentrated boric acid solution are required to be located within a heated area in order to maintain solution temperature at ≥ 65°F. If a portion of the system which normally contains concentrated boric acid solution is not located in a heated area, it is provided with some other means (e.g., heat tracing) to maintain solution temperature at ≥ 65°F.

The reactor makeup water pumps, taking suction from the reactor makeup water storage tank, are employed for various makeup and flushing operations throughout the systems. One of these pumps starts on demand from the reactor makeup controller and provides flow to the suction header of the charging pumps or the volume control tank through the letdown line and spray nozzle.

d. <u>Boron Thermal Regeneration System</u>

Downstream of the mixed bed demineralizers, if load following operation were desired, the letdown flow can be diverted to the Boron Thermal Regeneration System where part or all of the letdown flow can be treated for boron concentration changes. After processing, the flow is returned to a point upstream of the reactor coolant filter.

Storage and release of boron if load follow operation is conducted, would be determined by the temperature of fluid entering the thermal regeneration demineralizers. A chiller unit and a group of heat exchangers would be 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 Boron Thermal Regeneration System is different for the boron storage and the boron release operations. During boron storage, the letdown stream enters the moderating heat exchanger and from there it passes through the letdown chiller heat exchanger. These two heat exchangers cool the letdown stream prior to its entering the demineralizers. The letdown reheat heat exchanger 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 heat exchanger. After passing through the demineralizers, the letdown enters the moderating heat exchanger shell side, where it is heated by the incoming letdown stream before going to the volume control tank.

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 heat exchanger tube side, bypasses the letdown chiller heat exchanger, and passes through the shell side of the letdown reheat heat exchanger. The moderating and letdown reheat heat exchangers 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 the temperature control valve which controls the flow rate on the tube side of the letdown reheat heat exchanger. After passing through the demineralizers, the letdown stream enters the shell side of the moderating heat exchanger, passes through the tube side of the letdown chiller heat exchanger and then goes to the volume control tank. The temperature of the letdown stream entering the volume control tank is controlled automatically by adjusting the shell side flow rate on the letdown chiller heat exchanger. 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 results in boron being released which 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.

For either of the above operating modes, the flow through the demineralizers can be adjusted from zero flow to the total letdown flow. Reduced flow through the demineralizers is achieved by adjusting the three-way valve located upstream of the demineralizers to split the flow so that a portion of the flow bypasses the demineralizers.

Although the Boron Thermal Regeneration System was initially primarily designed to compensate for xenon transients occurring during load follow, it can also be used to handle boron changes during other modes of plant operation. During startup dilution, for example, the resin beds would be first saturated, then washed off to the primary drain tank, then again saturated and washed off. This operation would continue until the desired dilution in the RCS was obtained. This method of startup serves to reduce the effluents diverted to the primary drain tank.

A thermal regeneration demineralizer can be used as a deborating demineralizer without the use of the chiller portion of the system. This can 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. This operation serves to reduce the effluents diverted to the primary drain tank.

To prevent RCS boron dilutions during shutdown operations, the thermal regeneration demineralizers are isolated in accordance with the Technical Specifications.

e. Component Description

A summary of principal CVCS component design parameters is given in Table 9.3-6, and safety classifications and design codes are given in Section 3.2.

1. Charging Pumps

Three charging pumps are supplied to inject coolant into the RCS. Two of the pumps are of the single speed, horizontal, centrifugal type while the third is a positive displacement (reciprocating) pump equipped with variable speed drive. All parts in contact with the reactor coolant are fabricated of austenitic stainless steel or other corrosion resistant material. To prevent leakage to the atmosphere, the centrifugal pump seals and the reciprocating pump stuffing box are provided with leak-offs to collect the leakage. The reciprocating pump design prevents lubricating oil from contaminating the charging flow. There is a minimum flow recirculating line to protect the centrifugal charging pumps from a closed discharge valve condition.

Charging flow rate is determined from a pressurizer level signal. The means of flow control for the reciprocating pump is by variation of pump speed. The reciprocating charging pump is also used to hydrotest the RCS. When operating a centrifugal charging pump, the flow paths remain the same but charging flow control is accomplished by a modulating valve on the discharge side of the centrifugal pumps. The centrifugal charging pumps also serve as high-head safety injection pumps in the Emergency Core Cooling System. A description of the charging pump function upon receipt of a safety injection signal is given in Subsection 6.3.2.2.

2. Boric Acid Transfer Pumps

   Two canned motor pumps are supplied. 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 will start 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 concentrated boric acid solution directly to the suction of the charging pumps, at a high flow rate, can be accomplished by manually starting either or both pumps. The transfer pumps also function to transfer boric acid solution from the batching tank to the boric acid tanks.

   The pumps are located in a heated area to prevent crystallization of the boric acid solution. All parts in contact with the solution are of austenitic stainless steel.

3. Chiller Pumps

   Two centrifugal pumps circulate the water through the chilled water loop in the Boron Thermal Regeneration System. If in the load following mode, one pump would normally be operated, with the second serving as a standby.

4. Regenerative Heat Exchanger

   The regenerative heat exchanger 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 heat exchanger while the charging stream flows through the tubes. The unit is constructed of austenitic stainless steel, and is of all-welded construction.

5. Letdown Heat Exchanger

The letdown heat exchanger cools the letdown stream to the operating temperature of the mixed bed demineralizers. Reactor coolant flows through the tube side of the exchanger while primary component cooling water flows through the shell side. All 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 heat exchanger, maintains the pressure of the letdown flow upstream of the heat exchanger in a range sufficiently high to prevent two-phase flow. Pressure indication and high pressure alarm are provided on the main control board.

The outlet temperature from the shell side of the heat exchanger is allowed to vary over an acceptable range compatible with the equipment design parameters and required performance of the heat exchanger in reducing letdown stream temperature.

6. Excess Letdown Heat Exchanger

The excess letdown heat exchanger cools reactor coolant letdown flow. The flow rate is equivalent to the portion of the nominal seal injection flow which flows into the RCS through the reactor coolant pump labyrinth seals.

The excess letdown heat exchanger can be employed either 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 component cooling water is circulated through the shell. All surfaces in contact with reactor coolant are austenitic stainless steel and the shell is carbon steel. All tube joints are welded.

7. Seal Water Heat Exchanger

The seal water heat exchangers are designed to cool fluid from three sources: reactor coolant pump number 1 seal leakage, reactor coolant discharged from the excess letdown heat exchanger, and miniflow from a centrifugal charging pump. Reactor coolant flows through the tube side of the heat exchanger and primary component cooling water 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 reactor coolant pump seal leakage, and miniflow from one centrifugal charging pump. The units are designed to cool the above flow to the temperature normally maintained in the volume control tank. All surfaces in contact with reactor coolant are austenitic stainless steel and the shell is carbon steel.

8. Moderating Heat Exchanger

In the load following mode, the moderating heat exchanger operates as a regenerative heat exchanger between incoming and outgoing streams to and from the thermal regeneration demineralizers.

The incoming letdown flow enters the tube side of the moderating heat exchanger. 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.

9. Letdown Chiller Heat Exchanger

During the boron storage operation for the load following mode, the process stream would enter the tube side of the letdown chiller heat exchanger after leaving the tube side of the moderating heat exchanger. The letdown chiller heat exchanger would cool the process stream to allow the thermal regeneration demineralizers to remove boron from the coolant. The desired cooling capacity would be adjusted by controlling the chilled water flow rate passed through the shell side of the heat exchanger.

The letdown chiller heat exchanger is also used during the boron release operation for the load following mode to cool the liquid leaving the thermal regeneration demineralizers to ensure that its temperature does not exceed that of normal letdown to the volume control tank.

10. Letdown Reheat Heat Exchanger

The letdown reheat heat exchanger would be used only during boron release operations for the load following mode to heat the process steam. Water used for heating is diverted from the letdown line upstream of the letdown heat exchanger, passed through the tube side of the letdown reheat heat exchanger and then returned to the letdown stream upstream of the letdown heat exchanger.

11. Letdown Degasifier

The letdown degasifier is designed to remove gases from the letdown stream before it is returned to the volume control tank. This degasifier is designed to process a maximum letdown flow of 120 gpm with a decontamination factor (DF) of approximately 10^4. For the normal flow rate of 80 gpm, the DF will be approximately 10^5. DF is defined as follows:

Gas Activity of Influent Liquid

DF = Gas Activity of Effluent Liquid

The letdown degasifier serves as a backup unit to the primary drain tank degasifier in the Boron Recovery System (Subsection 9.3.5).

The CVCS may be operated with or without the degasifier in operation. The degasifier has no safety function and is classified as NNS.

Downstream of the degasifier, hydrogen is injected into the degasifier effluent to maintain the required equilibrium hydrogen concentration before being returned to the volume control tank.

In the event that the degasifier is out of service, the letdown flow is directed to either the volume control tank or the primary drain tank as required to maintain proper volume control tank liquid levels.

The arrangement of the degasifier in the CVCS is shown in Figure 9.3-32.

The liquid entering the degasifier is first heated up in regenerative and steam heat exchangers to approximately 200°F and then is sprayed into the gas striping column of the degasifier. The liquid flows down over packing in the column and into the hotwell where it is further stripped of the remaining gas by being heated to 228°F by steam heat coils.

A portion of the cold influent stream is sprayed into the gas collection area in the dome at the top of the column to assist in cooling the condensible vapors. The noncondensible gases are vented out to the Waste Gas System by a modulating control valve. Gases from an oxygenated letdown sequence (pre- or post-refueling) may be directed to the aerated vent header, as directed by reactor coolant chemistry to minimize oxygen accumulation in the Waste Gas System. Nitrogen purging will be performed as necessary prior to any degasifier vent line alignment change.

The degassed liquid is pumped from the hotwell of the unit through the regenerative heat exchanger and trim cooler, finally leaving the degasifier at a temperature of 115°F. A modulating control valve, acting in response to signals from the volume control tank level instruments, splits the effluent flow between the volume control tank and the cesium removal ion exchanger in the Boron Recovery System.

That part of the flow directed to the volume control tank first goes through the hydrogen injector where H_2 gas is injected into the flow stream. The rate of H_2 injection is controlled by flow sensing instrumentation. The H_2-rich liquid passes through a static mixer section which insures a homogeneous liquid/gas mixture going into the volume control tank.

12. Volume Control Tank

The volume control tank 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 Boron Recovery System. The tank also provides a means for introducing hydrogen into the coolant to maintain the required equilibrium concentration of hydrogen in the water and is used for degassing the reactor coolant. It also serves as a head tank for the charging pumps.

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 Gaseous Waste Processing System) is continuously supplied to the volume control tank while a remotely operated vent valve, discharging to the Gaseous Waste Processing System, permits continuous removal of gaseous fission products which are stripped from the reactor coolant and collected in this tank. Normally, the fission gas removal is accomplished by the letdown degasifier which is located upstream of the volume control 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 reactor coolant pumps although this flow normally goes directly to the suction of the charging pumps.

13. Boric Acid Tanks

The combined boric acid tank capacity is sized to store sufficient boric acid solution for refueling plus enough for a cold shutdown from full power operation immediately following refueling with the most reactive control rod not inserted.

The concentration of boric acid solution in storage is maintained between 4 and 4.4 percent by weight (7000 to 7700 ppm). Periodic manual sampling and corrective action, if necessary, assure that these limits are maintained. Therefore, measured amounts of boric acid solution can be delivered to the reactor coolant to control the boron concentration.

14. Batching Tank

The batching tank is used for mixing a makeup supply of boric acid solution for transfer to the boric acid tanks.

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 an electrical heater for heating the boric acid solution.

15. Chemical Mixing Tank

The primary use of the chemical mixing tank is in the preparation of lithium hydroxide solutions for pH control, hydrazine solution for oxygen scavenging, and chemicals for corrosion product oxidation during a refueling shutdown.

16. Chiller Surge Tank

If in the load following mode, the chiller surge tank would handle the thermal expansion and contraction of the water in the chiller loop. The surge volume in the tank also would act as a thermal buffer for the chiller.

17. Mixed Bed Demineralizers

Two flushable mixed bed demineralizers are used in maintaining reactor coolant purity. A lithium-form cation resin and hydroxyl-form anion resin are normally 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 decontamination factor of 10.

Each demineralizer has more than sufficient capacity for one core cycle with one percent of the rated core thermal power being generated by defective fuel rods. One demineralizer is in service with the other in standby or both demineralizers are in service operating in parallel.

To support plant shutdown activities, particulate removal resins may be charged into the demineralizers in conjunction with mixed bed resins.

18. Cation Bed Demineralizers

A flushable demineralizer with cation resin in the hydrogen form is located downstream of the mixed demineralizers and is used intermittently to control the concentration of lithium-7 which builds up in the coolant from the $B^{10}(n,\alpha)Li^{7}$ reaction. The demineralizer also has sufficient capacity 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.

The 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.

19. Thermal Regenerative Demineralizers

The function of the thermal regeneration demineralizers if load following operation is conducted would be 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 demineralizers 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 capacity varies from the beginning of a core life to the end of core life by a factor of about 2.

The demineralizers are of the type that 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 if load following operation was desired. 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 on the resin will gradually decrease, thus reducing the capability of the resin to remove boron form the process stream. Degradation of ion removal capability will occur for temperatures of approximately 160°F and above. The extent of degradation and 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.

If in the load following mode, 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 would be 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 into the core to maintain power level. If the rods were to reach the insertion limit setpoint, an alarm would be actuated informing the operator that emergency boration of the RCS is necessary in order to maintain capability of shutting the reactor down with control rods alone.

Although the thermal regenerative demineralizers were initially designed to compensate for xenon transients occurring during load follow, they can be used to make RCS boron concentration changes during other modes of plant operation. A thermal regeneration demineralizer can be used as a deborating demineralizer without the use of the chiller portion of the BTRS. This can be used to dilute the RCS down to very low, close to zero ppm boron. Another example of dilution capability is during startup operation, during which the resin beds can first be saturated, then washed off to the primary drain tank, then again saturated and washed off. This operation would continue until the desired dilution in the RCS were obtained. The above-described methods serve to reduce the effluents diverted to the primary drain tank.

20. Demineralizer Pre-Filter

The demineralizer pre-filter is provided to collect particulates from the letdown stream. The filter is located upstream of the mixed bed demineralizers. The vessel is provided with connections for draining and venting. The nominal flow capacity of the filter is equal to the maximum purification flow rate.

21. Reactor Coolant Filter

The reactor coolant filter is located in the letdown line upstream of the volume control tank. The filter collects resin fines and particulates from the letdown stream. The nominal flow capacity of the filter is greater than the maximum purification flow rate.

22. Seal Water Injection Filters

    Two seal water injection filters are located in parallel in a common line to the reactor coolant pump 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.

23. Seal Water Return Filter

    This filter collects particulates from the reactor coolant pump 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 reactor coolant pumps.

24. Boric Acid Filter

    The boric acid filter collects particulates from the boric acid solution being pumped from the boric acid tanks by the boric acid transfer pumps. The filter is designed to pass the design flow of two boric acid transfer pumps operating simultaneously.

25. Letdown Valves

    Two high pressure letdown valves are provided in parallel to reduce the letdown pressure from reactor conditions and to control the flow of reactor coolant leaving the RCS. Each valve is designed for somewhat greater than normal letdown flow, one valve is normally operated with the other serving as standby. The standby valve may be used together with the normally operating valve either for flow control when the RCS pressure is less than normal or for greater letdown flow during maximum purification or during heatup. Each valve is made of austenitic stainless steel or other adequate corrosion resistant material.

    A low pressure letdown valve located downstream of the letdown heat exchanger controls the pressure downstream of the letdown heat exchanger to prevent flashing of the letdown liquid upstream of the letdown heat exchanger.

26. Chiller

The chiller is located in a chilled water loop containing a surge tank, chiller pumps, the letdown chiller heat exchanger, piping, valves and controls.

The purpose of the chiller, if in service for load following operation, is two-fold:

(a) To cool down the process stream during storage of boron on the resin

(b) To maintain an outlet temperature from the Boron Thermal Regeneration System at or below 115°F during release of boron.

27. Valves

Where pressure and temperature conditions permit, diaphragm-type valves are used essentially eliminating leakage to the atmosphere. All packed valves that are larger than 2 inches and which are designated for radioactive services were originally provided with a stuffing box and lantern leakoff connections. All control (modulating) and three-way valves are either provided with stuffing box and leakoff connections or are totally enclosed. Several valves that had exhibited a history of leakage were subsequently modified to eliminate the leakoff connection in accordance with industry recommendations. Leakage to the atmosphere is essentially zero for these valves. Basic construction material is stainless steel for all valves which handle radioactive liquid or boric acid solutions.

Relief valves are provided for lines and components that might be pressurized above design pressure by improper operation or component malfunction.

(a) Charging Line Downstream of Regenerative Heat Exchanger

If the charging side of the regenerative heat exchanger is isolated while the hot letdown flow continues at its maximum rate, the volumetric expansion of coolant on the charging side of the heat exchanger is relieved to the RCS through a spring-loaded check valve (see Figure 9.3-27, valve 3/4"-CS-V184 in line 368-3-3/4").

An exception to the ASME Code is provided as follows:

Manual block valve CS-V-183 is in the discharge path of the spring-loaded relief check valve CS-V-184. The check valve provides overpressure protection for CS-E-2 (Regenerative Heat Exchanger [RHE]) in the event of a Chemical and Volume Control System malfunction. The purpose of the block valve is to facilitate maintenance of the RHE.

This configuration is an exception to the requirements of the 1974 ASME Section III, Division I, NC-7153. NC-7153 allows the installation of stop valves on the inlet or discharge of relief valves, but requires positive "controls and interlocks." Positive "controls and interlocks" are not provided for this configuration as defined by the Code. This exception is acceptable because the block valve is part of the original standard design provided by Westinghouse, facilitates maintenance of the component, and has strict administrative controls for maintaining the valve in an open position during plant operation to ensure overpressure protection is not defeated.

(b) Letdown Line Downstream of High Pressure Letdown Valves

The pressure relief valve downstream of the high pressure letdown valves protects the low pressure piping and the letdown heat exchanger from overpressure when the low pressure piping is isolated. The capacity of the relief valve is equal to the maximum flow rate through both letdown valves. The valve set pressure is equal to the design pressure of the letdown heat exchanger tube side.

(c) 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 exceeds the maximum flow rate through both high pressure letdown valves. The valve set pressure is less than the design pressure of the demineralizers.

(d) Volume Control Tank

The relief valve on the volume control tank 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 letdown, normal seal water return, excess letdown, miniflow from one centrifugal charging pump and nominal flow from one reactor makeup water pump. The valve set pressure equals the design pressure of the volume control tank.

(e) Charging Pump Suction

A relief valve on the charging pump suction header relieves pressure that may build up if the suction line isolation valves are closed or if the system is overpressurized. The valve set pressure is equal to the design pressure of the associated piping and equipment.

(f) Seal Water Return Line (Inside Containment)

These relief valves are designed to relieve overpressurization in the seal water return piping inside the containment if the motor-operated isolation valve is closed. The valves are designed to relieve the total leakoff flow from the number 1 seals of the reactor coolant pumps plus the design excess letdown flow. The valves are set to relieve at the design pressure of the piping.

(g) Seal Water Return Line (Charging Pumps Bypass Flow)

This relief valve protects the seal water heat exchangers and their associated piping from overpressurization. If either of the isolation valves for the heat exchangers are 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 heat exchanger.

(h) 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.

(i) Letdown Reheat Heat Exchanger

The relief valve is located on the piping leading to the shell side of the heat exchanger. If the shell side were isolated while flow was maintained in the tube side, overpressurization could occur. The valve set pressure is less than the design pressure of the heat exchanger shell side.

(j) Letdown Chiller Heat Exchanger

The relief valve is located on the piping leading from the shell side of the heat exchanger. 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 heat exchanger shell side.

(k) Letdown Degasifier

The relief valve is located off the hotwell.

28. Piping

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.

f. System Operation

1. Reactor Heatup

Reactor startup is defined as the operations that bring the reactor from cold shutdown to normal operating temperature and pressure.

It is assumed that:

(a) Normal residual heat removal is in progress.

(b) RCS boron concentration is at the cold shutdown concentration.

(c) Reactor Makeup Control System is set to provide makeup at the cold shutdown concentration.

(d) RCS is drained to minimum level for the purpose of refueling or maintenance with the reactor pressure vessel head installed.

(e) The charging and letdown lines of the CVCS are filled with coolant at the cold shutdown boron concentration. The high pressure letdown valves are both fully closed.

The RCS filling and venting procedure is as follows:

(a) One charging pump is started, which provides blended flow from the Reactor Makeup Control System at the cold shutdown boron concentration.

(b) The vents on the head of the reactor vessel and pressurizer are opened.

(c) The RCS is filled and the vents closed.

The system pressure is raised by using the charging pump and controlled by the low pressure letdown valve (letdown is achieved via the RHRS). When the system pressure is adequate for operation of the reactor coolant pumps, 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.

As an alternative to the venting process described above, the RCS may be filled while operating an evacuation system (see Section 9.3.6.2). This system draws air from within the RCS, through the RCS, through the reactor vessel head vent and the top of the pressurizer. Once vacuum is established the RCS level is raised using the charging system. This method reduces the number of RCP starts required to sweep the loops and aids in establishing proper water chemistry. The pressurizer level may be established at near normal levels for the formation of the steam bubble, as opposed to being filled as is required for the venting method.

If "water solid" heatup is to be used, after completion of venting the pressurizer is refilled, charging and letdown flows are established, and the RCS is pressurized. All pressurizer heaters are energized and the reactor coolant pumps are employed to heat up the system. After the reactor coolant pumps are started, the residual heat removal pumps are stopped but pressure control via the RHRS and the low pressure letdown line is continued as the pressurizer steam bubble is formed. At this point, steam formation in the pressurizer is accomplished by manual control of the charging flow and automatic pressure control of the letdown flow. 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 now used to increase RCS pressure.

If the "steam bubble" heatup is to be used, after completion of venting the system is depressurized to atmospheric and the pressurizer level decreased to the no-load value. The level then remains at or near this value (approximately 25%) throughout the heatup. The heatup is initiated by shutting off cooling water flow to the residual heat exchangers and energizing the pressurizer heaters. This allows slow heating of the RCS on core residual heat coincident with controlled pressurizer heating. When the saturation temperature for the existing low pressure is reached the pressurizer heatup is suspended briefly to permit "streaming off" to the pressurizer relief tank of the air and any nitrogen present in the pressurizer. After this venting, pressurizer heatup is resumed and continues until saturation conditions at the pressure required for pump operation are reached. Then all reactor coolant pumps are started and RCS heatup proceeds at the maximum rate attainable on pump heat.

With either the "water solid" or "steam bubble" heatup modes, after the steam bubble has been established at the pressure required for reactor coolant pump operation, subsequent pressurizer heating is manually controlled. Pressurizer spray operation, when necessary for pressurizer pressure/temperature reduction, is also manually controlled.

The reactor coolant boron concentration is now reduced either by operating the Reactor Makeup Control System in the "dilute" mode or by operating the Boron Thermal Regeneration System as described in Section 9.3.4.2.d.

The reactor coolant boron concentration is corrected to the point where the appropriate 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 adjustment of the high pressure letdown valves 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 Reactor Makeup Control System is operated on a continuing basis to ensure correct control rod position. Chemicals are added through the chemical mixing tank as required to control reactor coolant chemistry such as pH and dissolved oxygen content. Hydrogen overpressure is established in the volume control tank to assure the appropriate hydrogen concentration in the reactor coolant.

2. Power Generation and Safe Shutdown Operation

(a) Base Load

At a constant power 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 automatically by control rod movement. If variations in power level occur, and the new power level is sustained for long periods, some adjustment 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 or both mixed bed demineralizers are 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 or the positive displacement pump speed controller, depending on which pump is in use.

(b) 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.

If load following operation were desired, the Boron Thermal Regeneration System may be used to vary the reactor coolant boron concentration to compensate for xenon transients occurring when reactor power level is changed. The Reactor Makeup Control System 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 of 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 letdown and accommodated in the volume control tank. During this period, the flow through the high pressure letdown valve remains constant and the charging flow is reduced by the pressurizer level control signal, resulting in an increased temperature at the regenerative heat exchanger outlet. The temperature controller downstream from the letdown heat exchanger increases the component cooling water 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.

(c) Hot Shutdown

If required, for periods of maintenance, or following spurious reactor trips, the reactor can be held subcritical, but with the capability to return to power within the period of time it takes to withdraw control rods. During this hot shutdown period, temperature is maintained at no-load T_{avg} by initially dumping steam to remove core residual heat, or at later stages, by running reactor coolant pumps to maintain system temperature.

Following shutdown, xenon buildup occurs and increases the degree of shutdown; i.e., initially, with initial xenon concentrations 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 xenon 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.

(d) Cold Shutdown

Cold shutdown is the operation which takes the reactor from hot shutdown conditions to cold shutdown conditions (reactor is subcritical by at least 1 percent $\Delta k/k$ and $T_{avg} \leq 200°F$).

Before initiating a cold shutdown, the RCS hydrogen concentration is lowered by reducing the volume control tank overpressure, by replacing the volume control tank hydrogen atmosphere with nitrogen, and by continuous purging to the Gaseous Waste Processing System.

Core reactivity is controlled during the cooldown by borating to cold shutdown conditions prior to initiating the cooldown. After the boration is completed and reactor coolant samples verify that the concentration is correct, the operator resets the Reactor Makeup Control System for leakage makeup and remaining system contraction at the shutdown reactor coolant boron concentration.

Contraction of the coolant during any remaining cooldown of the RCS results in actuation of the Pressurizer Level Control System to maintain normal pressurizer water level. The charging flow is increased, relative to letdown flow, and results in a decreasing volume control tank level. The volume control tank level controller automatically initiates makeup to maintain the inventory.

After the RHRS is placed in service and the reactor coolant pumps are shutdown, further cooling of the pressurizer liquid, if required, 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 reduce the reactor coolant activity level sufficiently to permit personnel access for refueling or maintenance operations.

3. Reactor Makeup Control System

The Reactor Makeup Control System can be set up for the following modes of operation:

(a) Automatic Makeup

The "automatic makeup" mode of operation of the Reactor Makeup Control System 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 selection switch is set in the "automatic makeup" position. This switch position establishes a preset control signal to the makeup batch flow indicating controller, and establishes positions for the makeup stop valves for automatic makeup. The boric acid flow rate setpoint is set on the makeup batch flow indicating controller to blend the same concentration of borated water as contained in the RCS. A preset low level signal from the volume control tank level controller causes the automatic makeup control action to start a reactor makeup water pump, start a boric acid transfer pump, open the makeup stop valve to the charging pump suction, and position the boric acid flow control valve and the 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 volume control tank 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 from both channels opens the stop valves in the refueling water supply line to the charging pumps, and closes the stop valves in the volume control tank outlet line.

(b) Dilution

The "dilute" mode of operation permits the addition of the preselected quantity of reactor makeup water at a preselected flow rate to the RCS. The operator sets the mode selector switch to "dilute," the total makeup flow rate setpoint and target quantity on the makeup batch flow indicating controller and initiates system start. This opens the reactor makeup water flow control valve, opens the makeup stop valve to the volume control tank inlet, and starts a reactor makeup water pump. Excessive rise of the volume control tank 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 primary drain tank. 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 can also be accomplished by operating the Boron Thermal Regeneration System in the boron storage mode, or by the use of deborating resins in the demineralizers.

(c) Alternate Dilution

The "alternate dilute" mode of operation is similar to the dilute mode, except that a portion of the dilution water flows directly to the charging pump suction, and a portion flows into the volume control 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 volume control tank.

(d) 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," the concentrated boric acid flow rate setpoint and target quantity are set on the makeup batch flow indicating controller, 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 pump, which 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 volume control tank level. When the preset quantity of concentrated boric acid solution is added, the batch integrator of the makeup batch flow indicating controller causes makeup to stop. Also, the operation may be terminated manually at any time.

Normal boration can also be accomplished, using the emergency boration path, by opening CS-V426 and starting a boric acid pump.

Boration can also be accomplished by operating the Boron Thermal Regeneration System in the boron release mode.

(e) Manual

The "manual" mode of operation permits the addition of a preselected quantity and blend of boric acid solution to the refueling water storage tank, to the primary drain tank, to the spent fuel pit, or to some other location via a temporary connection. Manual mode also permits the addition of reactor makeup water directly to the RCS. 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," the boric acid and total makeup flow rates and boric acid and total makeup target quantities on the makeup batch flow indicating controller 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, as required.

When the preset quantities of boric acid and reactor makeup water have been added, the batch integrators of the makeup batch flow indicating controller cause makeup to stop. This operation may be stopped manually by actuating the makeup stop switch.

If either batch integrator of the makeup batch flow indicating controller is satisfied before the other has recorded its required total, the integrator which has been satisfied will terminate flow. The flow controlled by the other integrator will continue 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 percent boric acid solution.

The Reactor Makeup Control System incorporates a stepback feature in all modes except AUTO to minimize batch overshoot. The stepback feature reduces boric acid and reactor makeup water flow rates as the makeup batch approaches its target quantities.

The quantities of boric acid and reactor makeup water injected are totalized by the batch counters. During the batch makeup, flow rates are available for display on the Main Control Board (MCB) and are recorded in the Main Plant Computer System (MPCS). Deviation alarms sound for both boric acid and reactor makeup water if flow rates deviate from setpoints.

During certain blended makeups in AUTO or MANUAL mode, where the required boric acid flow rate is below a low flow setpoint, the control system implements a pulsed boric acid injection algorithm. The control system opens and closes the boric acid flow control valve as required during the makeup batch to achieve desired batch boron concentration.

4. Letdown Degasifier Operation

The letdown degasifier may be operated during any mode of CVCS operation to process the letdown fluid. Operation of the degasifier is as follows:

(a) Startup

The system is slowly warmed up and operated on re-circulation until the liquid is thoroughly degassified. Then the influent and effluents may be realigned to process letdown flow.

The system must be purged with nitrogen prior to processing aerated liquids to the plant vent.

To avoid returning water to the RCS with a different boron concentration, the degasifier discharge is directed to the boron recovery system cesium removal ion exchanger (Subsection 9.3.5) for a sufficient time to insure that the degasifier effluent is representative of the RCS liquid.

(b) Normal Operation/Hot Standby

The letdown degasifier will automatically adjust all system operating parameters for all flow conditions from the 120 gpm maximum to no-flow or hot-standby.

(c) Shutdown

The system is transferred to re-circulation mode and allowed to slowly cool down.

The system must be purged with nitrogen prior to performing any maintenance on the system.

Although the degasifier is normally shut down per procedure, nonnuclear-safety pressure instrumentation is provided, for the vessel, to isolated inlet flowpaths on abnormally high pressure. Nonnuclear-safety flow instrumentation is provided on relief valve discharge piping as a backup to the pressure instrumentation. Relief valve discharge piping is routed to the release recovery quench tank which contains 15 ft^3 of available collection volume.

9.3.4.3 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 NRC General Design Criteria for the plant systems, components and structures important to safety is discussed in Section 3.1. Also, Section 1.8 provides a discussion on applicable regulatory guides.

a. Reactivity Control

Any time that the plant is at power the quantity of boric acid retained and ready for injection always exceeds that quantity required for normal cold shutdown immediately following refueling 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 refueling water storage tank 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 Subsection 15.4.6).

Two separate and independent flow paths are available for reactor coolant boration, i.e., the charging line and the reactor coolant pump seal injection line. A single failure does not result in the inability to borate the RCS. A third path exists via the cold leg injection line when the charging pump is aligned to the refueling water storage tank. This path may be used if the normal charging header is removed from service.

As backup to the normal boric acid supply, the operator can align the refueling water storage tank 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. Therefore, the Technical Specifications require action to effect repairs of an inoperable component, restrict permissible repair time, and require demonstration of the operability of the redundant component.

b. 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 or both 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 the cation bed demineralizer 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. The cation bed demineralizer is capable of passing the maximum purification letdown flow. Each mixed 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 placed in service or both demineralizers can be operated in parallel. 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 residual heat removal operations. A remote operated valve admits a bypass flow from the RHRS into the letdown line at a point upstream of the letdown heat exchanger. The flow passes through the heat exchanger and then passes through one of the mixed bed demineralizers and the reactor coolant filter to the volume control tank or RHR pump suction. The fluid is then returned to the RCS via the normal charging route.

The maximum temperature that will be 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 so as 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 further 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.

c. Seal Water Injection

Flow to the reactor coolant pump seals is assured since there are three charging pumps, any one of which is capable of supplying the normal charging line flow plus the nominal seal water flow.

To provide increased reliability for seal injection, a crossconnect from the fire protection and demineralized water systems to the PCCW system was added to provide alternate cooling to the charging pump lube oil coolers. This crossconnect can be used to provide cooling water to the charging pump lube oil coolers in the event that the PCCW system is unavailable.

d. Leakage Provisions

CVCS components, valves, and piping which are in radioactive service are designed to limit leakage to the atmosphere. The following are preventive means which are provided to limit radioactive leakage to the environment.

1. Where pressure and temperature conditions permit, diaphragm type valves may be used essentially eliminating leakage to the atmosphere.

2. All packed valves which are larger than 2 inches and which are designated for radioactive service are provided with a stuffing box and lantern leakoff connections.

3. All control (modulating) and three-way valves are either provided with stuffing box and leakoff connections or are totally enclosed.

4. Welding of all piping joints and connections except where flanged connections are provided to facilitate maintenance and hydrostatic testing.

The volume control tank provides inferential measurement of leakage from the CVCS as well as the RCS. The amount of leakage can be inferred from the amount of makeup added by the Reactor Makeup Control System.

During normal operation, the hydrogen and fission gases are stripped from the letdown by the letdown degasifier. This is done 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. Alternatively, the hydrogen and fission gases can be continuously purged from the volume control tank to the gaseous waste processing system. Also provided are the mixed bed and cation bed demineralizers which maintain reactor coolant purity, thus reducing the radioactivity level of the RCS water.

e. Ability to Meet the Safeguards Function

The failure mode and effects analysis (FMEA), summarized in Table 9.3-7 demonstrates that single component failures do not compromise the CVCS safe shutdown functions of boration and makeup. This analysis also shows that single failures occurring during CVCS operation do not compromise the ability to prevent or mitigate accidents. The capabilities are accomplished by a combination of suitable redundance, instrumentation for indication and/or alarm of abnormal conditions, and relief valves to protect piping and components against malfunctions.

The CVCS shares components with the ECCS and containment isolation functions. These safeguard functions of the CVCS are addressed in Section 6.3, and included in the ECCS FMEA presented in Table 6.3-5.

f. Heat Tracing

Heat tracing requirements for boric acid solutions depend mainly on the solution concentration. The concentration of boric acid in the CVCS ranges from 10 ppm to 4-weight percent (7000 to 7700 ppm) boric acid. Electrical heat tracing is not required on any CVCS components which contain 4-weight percent boric acid, providing these components are located in a room maintained at 65°F or higher. Temperature alarms are provided to alert the operators if room temperature goes below 65°F. Refer to Subsection 9.3.4.2 for more information.

g. Abnormal Operation

The CVCS is capable of making up for abnormal RCS leaks using normal charging header flow path and still maintain seal injection flow to the reactor coolant pumps. Letdown can be isolated to compensate for RCS cooldown contraction.

h. Station Blackout

Makeup systems are not required during Station Blackout conditions because reactor coolant inventory loss should not result in the core's becoming uncovered during the four-hour coping duration (see Section 8.4.4.6).

9.3.4.4 Tests and Inspections

Testing of the CVCS during the initial test program is described in Chapter 14.

During 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 (Chapter 16) have been established concerning the operability of CVCS components for reactivity control and CVCS capability.

9.3.4.5 Instrumentation Application

Process control instrumentation is provided to acquire data concerning key parameters about the CVCS. The location of the instrumentation is shown on Figure 9.3-26, Figure 9.3-27, Figure 9.3-28, Figure 9.3-29, Figure 9.3-30, Figure 9.3-31 and Figure 9.3-32.

a. <u>Positive Displacement Charging Pump (P-128)</u>

The positive displacement charging pump is controlled from the main control board (MCB). The pump starts when the control switch is placed in the "start" position, the breaker is in the operated position, and recirculation valve V205 is in the full open position. Speed of the pump, and correspondingly pump flow rate, is controlled automatically from the pressurizer level control circuitry via a speed controller device located on the MCB. Pump trip is via electric overloads, control switch "stop" positive, or low lube oil pressure to the pump. Pump trip and pump packing coolant low level are alarmed on the MCB. Pump status lights ("Run," "Stop," "Auto-Trip") are provided at the control switch. Pump suction and discharge pressure indications are provided by local instrumentation. Pump flow output is indicated on the MCB and locally at the pump. Motor current is indicated on the MCB. This pump flow output signal is input to the Pressurizer Level Control System and to the Flow Control Valve (FCV-121) System.

b. <u>Centrifugal Charging Pumps (P-2A and 2B)</u>

Location of operation of the centrifugal charging pups is selectable from the selector switch located in the switchgear room. "Local" operation is via the control switch in the switchgear room; "Remote" operation is via the control switch at the MCB. Pump status lights are provided at each control switch. Placing the selector switch in the "local" position de-energizes the "remote" status lights and alarms on the MCB. Pump inoperative status and breaker lockout are also alarmed on the MCB. Winding, inboard bearing and outboard bearing temperatures for the pumps are monitored and alarmed in the main control room (MCR). Pump suction and discharge pressures are indicated via local instrumentation. Pump discharge pressure to the seal injection filters is indicated and alarmed (low, low-low) in the MCR. The charging pumps are also provided with auxiliary lube oil pumps (P-243A and B) which are started automatically when charging pump lube oil pressure is low. The control switch and status lights are located locally at the pumps (P-243A and P-243B). The trouble alarms for these auxiliary lube oil pumps are located on the MCB.

c. Boric Acid Transfer Pumps (P-3A and 3B)

A selector switch located at the motor control center (MCC) for each boric acid transfer pump allows for selection of control of either the MCB or at the MCC. Status lights at each control switch location indicate whether the pump is running or not. Placing the selector switch in the "local" (MCC) position is alarmed on the MCB and de-energizes the status lights on the MCB. Pump start is either manual via the control switches and selector switch or automatic via a makeup permit signal from the Boric Acid Blend Control System. Pump discharge and suction pressure indication as well as flow indication to the boric acid tanks are provided via instrumentation local to the pumps.

d. Chiller Pumps (P-7A and 7B)

Chiller pump control is either manual or automatic via a control switch on the MCB. Status lights above the control switch indicate whether or not the pump is running. When the control switch is in the "Auto" position, the pump will start automatically by the presence of a "Dilute" or "Borate" control signal generated by the Thermal Regeneration Switching System. Pump suction and discharge pressures are indicated via instrumentation local to the pumps.

e. Regenerative Heat Exchanger (E-2)

The temperatures of both outlet streams from the heat exchanger are monitored, with indication given in the control room. High temperature alarms are actuated on the main control board if the temperature of the letdown stream exceeds desired limits.

f. Letdown Heat Exchanger (E-4)

The letdown temperature control indicates and controls the temperature of the letdown flow exiting from the letdown heat exchanger. A temperature sensor, which is part of the CVCS, provides input to the controller in the Component Cooling Water System. The exit temperature of the letdown stream is thus controlled by regulating the component cooling water flow through the letdown heat exchanger. Temperature indication and alarms are provided on the main control board. If the outlet temperature from the heat exchanger is excessive, high temperature alarm is actuated and a temperature controlled valve diverts the letdown directly to the volume control tank.

g. Excess Letdown Heat Exchanger (E-3)

A temperature detector measures the temperature of the excess letdown flow downstream of the excess letdown heat exchanger. 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 heat exchanger and excess letdown control valve. Pressure indication is provided on the main control board.

h. Volume Control Tank (TK-1)

Volume control tank pressure is monitored, with indication given in the control room. Alarms are actuated in the control room for high and low pressure conditions.

Two level channels govern the water inventory in the volume control tank. Level indication, with high, low, and low-low alarms, is provided on the main control board for one controller. Local level indication, with high, low, and low-low alarms on the main control board, is provided for the other controller.

If the volume control tank level rises above the normal operating range, one level channel provides an analog signal to the proportional controller which modulates the three-way valve downstream of the reactor coolant filter to maintain the volume control tank level within the normal operating band. The three-way valve can split letdown flow so that a portion goes to the boron recovery system and a portion to the primary drain tank. The controller would operate in this fashion during a dilution operation when reactor makeup water is being fed to the volume control tank from the Reactor Makeup Control System.

If the modulating function of the channel fails and the volume control tank 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.

During normal power operation, a low level in the volume control tank initiates automatic makeup which injects a pre-selected blend of boric acid solution and reactor makeup water into the charging pump suction header. When the volume control tank level is restored to normal, automatic makeup stops.

If the automatic makeup fails or is not aligned for operation and the tank level continues to decrease, low level alarm is actuated. Manual action may correct the situation or, if the level continues to decrease, a low-low signal from both level channels opens the stop valves in the refueling water supply line, and closes the stop valves in the volume control tank outlet line.

i. Boric Acid Tanks (TK-4A and 4B)

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 boric acid tank. Level indication with high, low, 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 alarm warns the operator to start makeup to the tank. The low-low alarm is set to indicate the minimum level of boric acid in the tank to ensure sufficient boric acid is available for a cold shutdown with one stuck rod. The empty level alarm is set to give warning of loss of pump suction.

j. Chiller Surge Tank (TK-3)

The fluid level in the tank is monitored, with level indication and high and low level alarms provided on the main control board.

k. Cation and Mixed Bed Demineralizers (DM-1, 2A and 2B)

A temperature sensor monitors the temperature of the letdown flow downstream of the letdown heat exchanger. If the letdown temperature exceeds the maximum allowable resin operating temperature (approximately 140°F), a three-way valve is automatically actuated so that the flow bypasses the demineralizers. Temperature indication and an alarm are provided on the main control board. The air-operated three-way valve failure mode directs flow to the volume control tank. A high differential pressure alarm to note demineralizer fouling is also provided on the MCB.

l. Thermal Regeneration Demineralizers (DM-3A, 3B, 3C, 3D and 3E)

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 heat exchanger 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 exchanger to maintain the process flow 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. When reaching the high temperature setpoint, an alarm is sounded on the main control board and the letdown flow is diverted to the volume control tank from a point upstream of the mixed bed demineralizers.

m. Seal Water Injection Filters (F-4A and 4B)

A differential pressure transmitter monitors the pressure across each seal water injection filter and provides indication at the Main Plant Computer System. A high differential pressure alarm is provided on the main control board.

n. Letdown Valves (HCV-189, HCV-190 and PCV-131)

A flow monitor downstream of the high pressure letdown valves provides indication in the control room of the letdown flow rate, and a high flow alarm to indicate unusually high flows.

Pressure indication and a high pressure alarm are provided on the main control board to monitor pressure upstream of the low pressure control valve.

o. Letdown Line Isolation Valves (V-149 and V-150)

These valves close automatically on a "T" or HELB signal.

9.3.5 Boron Recovery System

The Boron Recovery System processes reactor coolant and primary drain water for possible reuse as primary grade water and boric acid, or for offsite disposal.

9.3.5.1 Design Bases

The Boron Recovery System is designed as NNS (nonnuclear safety) class and nonseismic Category I.

The Boron Recovery System is designed to:

a. Process the reactor coolant letdown liquid generated by normal operations under either base loaded or load-following conditions.

b. Handle one cold shutdown-startup sequence at any time prior to the fuel cycle being approximately 95 percent complete, with no boron evaporator availability.

c. Accommodate a back-to-back cold shutdown-startup sequence until the time the reactor is first "control limited" in its ability to follow a potential programmed weekly load schedule with limited boron evaporator availability (65 hours during the back-to-back sequence).

d. Permit startup from a cold shutdown condition. For conservatism, the plant is assumed to be in end-of-core-life conditions (50 ppm boron concentration), and evaporator availability is considered to be 75 percent of the time.

e. Produce distillate from the boron evaporator with a maximum of 5 ppm boron, and provide by means of the boron demineralizers (mixed bed ion exchange units) the capability for reducing the boron concentration further, if so desired.

f. Provide radioactivity decontamination and chemical purification such that: (1) for reuse within the station, the system effluent meets the chemical purity requirements for recycled reactor makeup water, and (2) for discharge from the station, the effluent meets required radioactivity release limitations.

g. Accept and process any hydrogenated liquid drains collected in the primary drain tank.

9.3.5.2 System Description

The Boron Recovery System (BRS), Figure 9.3-33, Figure 9.3-34, Figure 9.3-35, Figure 9.3-36, Figure 9.3-37 and Figure 9.3-38, is located in the Waste Processing Building. Operating flexibility is obtained through the combined use of the Boron Thermal Regeneration Subsystem (BTRS) of the Chemical and Volume Control System (CVCS) and the BRS.
The liquid sources entering the BRS primary drain tanks (PDT) are:

a. Discharge from the reactor coolant drain tank pumps and the reactor coolant drain tank heat exchanger of the hydrogenated portion of the Equipment and Floor Drain System.

b. Letdown diverted from the Chemical and Volume Control System during high volume control tank level conditions.

c. Flushing water from the discharge of safety injection accumulators of the Safety Injection System.

d. Discharge from the relief valves of the chemical and volume control tank and charging pumps of the Chemical and Volume Control System.

e. Discharge from the combined relief valve header of the Safety Injection and Residual Heat Removal Systems.

f. Drainage from the Radioactive Gaseous Waste System.

g. Part drainage from the sample system.

Different quantities of liquid flow from the sources listed above, with the maximum continuous source coming from the reactor coolant letdown when one of the letdown degasifiers is inoperative. This can vary from a normal flow rate of 80 gpm to a maximum of 120 gpm. The other sources have either smaller flow rates or are of such a short duration that the flow can be temporarily accumulated within the PDT. The BRS is, therefore, designed to process 120 gpm.

Processing of the excess reactor coolant letdown and other water in the primary drain tank is accomplished in the BRS by first degasifying and then passing the liquid through the Post-PDT demineralizers and filters, evaporators and demineralizers before the process effluent is discharged to either the Reactor Makeup Water System (Subsection 9.2.7) or the Radioactive Liquid Waste System (Section 11.2). Bottoms from the recovery evaporators are cooled, filtered and sent either to the boric acid tanks in the CVCS for reuse in the Reactor Coolant System or to the Radioactive Solid Waste System (Section 11.4) for solidification and offsite shipment.

The construction materials along with the essential design parameters for the BRS components, are given in Table 9.3-8.

The various system functions include:

a. Collection and Degasification

The liquid to be processed is collected in one of two primary drain tanks which are kept under H_2 pressure of 2 to 3 psig by the hydrogenated vent header.

Gases such as hydrogen, nitrogen, krypton, xenon, etc., are removed in the first step in the boron recovery process by degasification of the liquid collected in the PDT. The liquid is then pumped from the PDT to the degasifier through a prefilter. The feed to the degasifier is heated in the degasifier regenerative heat exchanger and preheater. The regenerative heat exchanger uses the hot degasifier effluent to heat the incoming feed, thereby reducing cooling and heating loads. Auxiliary steam is used in the preheater and the degasifier for the heat required in the degasification of the falling droplets of water in the degasifier. The feed enters the degasifier at near saturation conditions and is sprayed into small droplets.

Gases are carried upward, any escaping steam is condensed, and gases are cooled by passing over a cooler within the degasifier. The gases are collected by the hydrogenated vent header for transfer to the Radioactive Gas Waste Management System (Section 11.3). The letdown degasifier can be used instead of or in parallel with the PDT degasifier. After a manual startup, the operation is automatic, depending on levels in the tanks. During low flow into the PDT, PDT pumps do not start and the degasifier goes automatically into standby. Excessive conditions are alarmed (see Subsection 9.3.5.5).

The degasifier is normally shut down manually; however, nonnuclear-safety pressure instrumentation is provided, for the vessel, to isolate inlet flowpaths on abnormally high pressure. Nonnuclear-safety flow instrumentation is provided on relief valve discharge piping as a backup to the pressure instrumentation. Relief valve discharge piping is routed to the release recovery quench tank which contains $75 ft^3$ of available collection volume.

b. Storage

The liquid in the degasifier hotwell is pumped into one of the two boron waste storage tanks (BWST) through a cooler, a demineralizer and filter.

The demineralizer vessels should contain media which can effectively remove ionic or non-ionic contaminants, to achieve the best possible radionuclide removal. Normally, one vessel is in service with the other in standby; however, the piping is such that they can be operated in series if required. These ion exchangers are automatically bypassed on high temperature.

The degasified letdown is monitored by a radiation monitor before entering the boron waste storage tanks where it awaits further processing by the recovery evaporators. The tanks (225,000 gallons each) are sized so that, in conjunction with the recovery evaporators, the BRS can provide the capability for meeting a wide range of unit operating conditions (see Subsection 9.3.5.1). The contents of the BWSTs can also be transferred to the floor drain tank for processing.

Other sources of liquid which are transferred into these storage tanks include flows from letdown degasifier, boric acid tanks, and Spent Fuel Pool Cooling and Cleanup System. During periods where plant leakage rates exceed the testing and processing capacity of the liquid waste system, the BWSTs can also be used to store floor drain tank liquid prior to processing.

The liquid in the boron waste storage tanks may be pumped to a skid-mounted waste liquid processing system, a recovery evaporator or to the floor drain tank by one of the two recovery evaporator feed pumps which stop automatically on low level in the tank. Either pump is able to supply either evaporator or transfer to the floor drain tank. In addition, the liquid can be supplied to the Liquid Waste System for evaporation in the waste evaporator in case extra capacity is needed.

The boron waste storage tanks are surrounded by reinforced concrete dike walls and a weather-tight enclosure overhead. The dike walls are seismic Category I, and are of sufficient height to contain the full volume of both tanks. The tanks are protected from freezing by steam heater panels mounted directly on the tank surfaces. The tanks are vented to the aerated vent header, and contain no floating heads or seals.

c. Evaporation

Each recovery evaporator is provided with an external reboiler, a vapor-liquid separator and a tray section to reduce any liquid carryover and to maintain the boron content in the distillate at less than 5 ppm. Operation of each recovery evaporator is automatic on selector control from the Waste Management System (WMS) panel in the Waste Processing Building. If the evaporators become inoperative for any reason, means are available for rapid drainage and recycling back to the boron waste storage tanks or floor drain tank.

The recovery evaporator distillate from the distillate condenser is collected in the distillate accumulator from which it is continuously removed on level control by the recovery distillate pump, cooled in the recovery distillate cooler, and discharged to one of the two recovery test tanks. A small side stream from the recovery distillate pump is utilized for reflux in the fractionating column of the recovery evaporator.

Operating pressure of the evaporator is maintained at 15 psig by automatic regulation of cooling water to the distillate condenser. Noncondensible gases that are removed from the liquid phase in the recovery evaporator are discharged from the recovery distillate condenser to the aerated vent header (see Subsection 9.3.6).

When the concentration of the boric acid in the recovery evaporator bottoms is at the desired value of about 4 percent by weight, the reclaimed boric acid is sampled and pumped through the recovery evaporator bottoms cooler and recovery evaporator bottoms filters to the boric acid tanks in the CVCS. The recovery evaporator bottoms cooler is designed to reduce the bottoms temperature from approximately 250°F to 150°F. The bottoms coolers are flushed by the distillate coming from the distillate pump discharge line.

When packaging of the recovery evaporator bottoms is desired for offsite shipment, the boric acid concentration in the bottoms is increased to about 12 percent by weight. The bottoms are then pumped to the Solid Waste System for solidification in a shipping container.

All lines in the BRS containing liquids with 4 percent or greater by weight of boric acid are electrically heat-traced with redundant circuits to prevent precipitation of boric acid.

The evaporator can be placed in a hot standby mode during any equipment malfunctions, alarms, changing feed or tanks, etc. Evaporator shutdown is manual.

d. Testing and Demineralization

The liquid pumped from the recovery evaporator distillate accumulator, after passing through a radiation monitor, enters one of the two recovery test tanks. After one of the test tanks is filled, flow is transferred to the other tank. The contents of the filled tank are mixed (by circulating the contents with a recovery test tank pump), sampled, and if the analysis is suitable, pumped to a reactor makeup water storage tank (see Subsection 9.2.7). If the sample shows that the recovery test tank contents require further treatment, the contents are recycled through one of the recovery demineralizers and recycled back to the test tanks or boron waste storage tanks until the desired water quality is obtained. These demineralizers can also be used to clean up the liquid in the reactor makeup water storage tanks.

Other sources of liquid which can be transferred into the recovery test tanks include effluent from a skid-mounted waste liquid processing system should additional storage capacity be required prior to discharge.

After sampling, the recovery test tank liquid effluent can also be discharged to the circulating water discharge tunnel (see Section 11.2) through a radiation monitor (see Section 11.5). The radiation monitor will automatically terminate the discharge on high activity levels. (Subsection 11.2.3 discusses the estimated radioactivity release levels resulting from such discharges.) The test tank contains a diaphragm to exclude air from its contents. Also automatic is the shutoff of the recovery test tank pumps on low level in the tank. All other operations of testing are manual. Alarms are provided (see Subsection 9.3.5.5).

The control of each process within the BRS is basically automatic. Operation of the recovery evaporator is automatic on cycle initiation from the waste processing control board in the Waste Processing Building. Batch processing, recycling, and proper sampling of liquids ensure control of BRS effluent stream.

9.3.5.3 Safety Evaluation

The BRS performs no safety function, and is not required for the safe shutdown of the reactor. Accordingly, the system is designated NNS class. Also, because of the noncritical nature of this system, emergency electrical power is not provided.

The recovery evaporators are designed with external reboilers, a large liquid disengaging space above the bottoms, vapor-liquid separators and tray sections to reduce boron carryover to a minimum in the vapor. In addition, the evaporators are designed with low flow velocity throughout to further reduce any entrainment of vapor. Use of the recovery evaporators is expected to yield a minimum decontamination factor (defined as the ration of the specific activities of the bottoms and distillate) of greater than 10^4 for nonvolatiles in the worst case. This will reduce the amount of radioactivity in the recovery water to acceptable levels for reuse in the Reactor Makeup Water System.

The concentrated liquid is further treated in the Solid Waste System before disposal offsite. Moreover, dikes are provided around tanks to contain any spills. Other tanks installed in diked areas are the recovery test tank, the waste test tanks, the reactor makeup water storage tank, the refueling water storage tank, and the spray additive tank.

A malfunction analysis of the BRS is presented in Table 9.3-9, which tabulates the basic conditions and the safety features. There is a large surge capacity in the system so that nonavailability of an evaporator for a period of time can be tolerated.

9.3.5.4 Testing and Inspection Requirements

Prior to initial startup, the BRS is tested to verify proper operation of system equipment. During normal plant operation, the BRS is inspected frequently. This frequency is sufficient to ensure the proper performance of system components.

9.3.5.5 Instrumentation and Control

a. Tanks and Pumps

Control and remote instrumentation of the Boron Recovery System is located on the Waste Management System (WMS) panel in the Waste Processing Building (WPB). Tank level indication for low and high alarm is available at this panel. For those tanks in the tank farm area which are liable to freeze up, high and low temperature alarm is provided locally. Level interlocks and motor overload devices provide pump protection. Pump trips are alarmed at local panels.

b. Evaporators

Each evaporator can be individually controlled. Normally the operation of the evaporator is automatic with a manual start. The prime objective of the evaporator control is to maintain the level by modulating the feed valve. The auxiliary control loops automatically maintain evaporator pressure and distillate as well as concentrating temperature at predetermined values. In any case, if any one of the auto controls is lost, backup instrumentation with operator action maintains evaporator operation. Additionally, instrumentation for feed, temperature, pressure and level of evaporation is provided at the WMS panel. Evaporator concentrates are transferred after manual sampling and analysis. The following conditions are alarmed at the local control panels: evaporators, condensers and accumulators high and low levels; evaporator pressure high and low; coolers outlet temperature high and low; auxiliary steam flow high; pumps trip.

c. Radiation Monitoring

Radioactivity is monitored at a point at the inlet of the boron waste storage tanks downstream of the primary drain tank ion exchangers and recovery filters. Radiation monitoring at this point ensures that tanks and evaporators handle radioactive liquids within their specification limit, and also aids in determining the efficiency of removal of radioactive nuclides by the ion exchangers and recovery filters. A second radiation monitor at the inlet of the recovery test tanks guarantees the quality of water before reuse or discharge. Before final discharge into the environment via the circulating water discharge tunnels, the final level of radiation is monitored (see Section 11.2).

9.3.6 Equipment Vent System

9.3.6.1 Design Bases

The Equipment Vent System consists of three separate and distinct headers; an aerated vent header, a hydrogenated vent header, and a reactor coolant vent header. Local vents are not considered a part of this system but are vented to nearby ventilation system ducts.

a. The aerated vent header is designed to control radioactive vapors released in sumps (Waste Processing Building only) and tanks by holding a slightly negative pressure to ensure that air is drawn through the tank from the overflow line and into the vent header.

b. The hydrogenated vent header is designed to collect radioactive gases and hydrogen released from hydrogenated reactor coolant letdown and leakage sources. It provides a positive pressure of hydrogen as a cover gas on tankage collecting reactor coolant and provides surge volume for transient operation.

c. The reactor coolant vent header is designed to route potentially radioactive trapped gases form the Reactor Coolant System during fill and vent operations to a suitable filter prior to discharge.

d. The aerated and hydrogenated vent headers are designed to accept the maximum surge flow from all components simultaneously.

There is no cross-connection between the aerated and hydrogenated vent headers, except for their common discharge at the Primary Auxiliary Building normal ventilation cleanup exhaust unit.

9.3.6.2 System Description

a. Aerated Vent Header

The aerated vent header, Figure 9.3-41, receives vent gas that is predominantly air plus radioactive contaminants from various components in the Boron Recovery System (Subsection 9.3.5), the Liquid Waste System (Section 1.2), the Waste Solidification System (Section 11.4), the Steam Generator Blowdown System (Subsection 10.4.8), the Equipment and Floor Drainage System (Subsection 9.3.3), and the letdown degasifier during an oxygenated letdown sequence. The gas is then filtered and discharged to the atmosphere via the PAB normal ventilation cleanup exhaust unit.

b. Hydrogenated Vent Header

The hydrogenated vent header, Figure 9.3-41, collects radioactive contaminated hydrogen gas from the reactor coolant drain tank (RCDT), chemical volume control tank (CVCT), pressurizer relief tank (PRT) sample vessel, CVCT sample vessel, primary drain tank (PDT), primary drain tank degasifier and the letdown degasifier. Additionally, dependent on gaseous activity, the pressurizer may be purged to the hydrogenated vent header in preparation for outages. The collected gas is then processed through the Radioactive Gaseous Waste System (RGWS). See Section 11.3. After processing by the RGWS, the hydrogenated gas is either recycled to the vent system to act as a cover gas, returned directly to the Reactor Coolant System via the volume control tank, or directed to the Primary Auxiliary Building (PAB) exhaust unit via the vent header. The safety valve surge tank (SVST) provides additional header capacity and reduces the magnitude of pressure fluctuations within the header. Design requirements for the SVST are given in Table 9.3-10. A pressure regulating valve maintains a constant pressure of 2 psig in the influent line of the Radioactive Gaseous Waste System (RGWS) that serves to isolate the RGWS influent line from hydrogenated vent header pressure surges.

c. Reactor Coolant Vent Header

The reactor coolant vent header, Figure 9.3-41, provides for the evacuation of the Reactor Coolant System during filling operations. Additionally, dependent on gaseous activity, the pressurizer may be purged to the hydrogenated vent header via the reactor coolant vent header in preparation for outages. During normal plant operations, the reactor coolant vent header is isolated from the hydrogenated vent header by a locked-closed valve.

Prior to the Reactor Coolant System filling operation, the hydrogenated vent header is isolated from the reactor coolant vent header, except for a path to the PAB exhaust unit which is purged with nitrogen. The reactor coolant vent header is then connected to the components and piping of the Reactor Coolant System by the insertion of a spool piece between the vent line. A separator/silencer separates any entrained liquid which is then drained to containment sump "A".

Prior to entering an outage and the opening of the RCS, the pressurizer gas space may be purged to the PAB exhaust unit or the hydrogenated vent header dependent on gaseous activity. When routed to the hydrogenated vent header, the reactor coolant vent header is aligned to the pressurizer via the vent spool and purged with nitrogen. Following completion of the pressurizer purge the reactor coolant vent header is isolated from the hydrogenated vent header.

An evacuation pump is used during filling operations to direct the air from the reactor coolant vent header to the hydrogenated vent header where it is filtered and discharged to the atmosphere. Design requirements for the evacuation pump are given in Table 9.3-10.

An alternate means for evacuating the RCS during filling operations is provided by a portable evacuation skid. This skid uses an air-driven eductor that is connected to the reactor vessel head vent and the pressurizer vent. The portable evacuation skid does not utilize the hydrogenated vent header. Discharge from the portable evacuation skid is directed to the atmosphere via a HEPA filter.

9.3.6.3 Safety Evaluation

To eliminate the possibility of obtaining a flammable mixture of hydrogen and oxygen, the hydrogenated vent header is thoroughly purged with nitrogen prior to startup and immediately following its shutdown.

The aerated vent header may contain trace amounts of hydrogen during the administratively controlled oxygenated letdown sequence. However, due to continuous header flow, hydrogen accumulation will not occur.

The design flow transient in the hydrogenated vent header occurs during the filling of one primary drain tank (PDT) at a rate of 120 gpm over a period of ten minutes. With one PDT full, and the other PDT containing the most limiting level of fluid, the header pressure increases to a level which is less than the design pressure (15 psig).

The section of the hydrogenated vent header which penetrates the containment wall and its associated containment isolation valves are designated Safety Class 2, seismic Category I. All other piping and components in the Equipment Vent System are designated as Nonnuclear Safety Class.

The hydrogenated vent header is protected against overpressurization by a pilot-operated relief valve which directs the gas flow through HEPA filters and charcoal filters before discharging it to atmosphere via the plant vent stack. (The PAB exhaust unit is discussed in detail in Subsection 9.4.3.)

If the PAB exhaust unit is not available, the hydrogenated vent header is protected against overpressurization by an ASME code relief valve set at the system design pressure. This relief valve discharges to atmosphere through a separate particulate filter and charcoal filter. The pilot-operated relief valve is set at a lower pressure than the ASME code relief valve since it is the preferred relief path.

9.3.6.4 Testing and Inspection Requirements

Periodic testing of the Equipment Vent System is not necessary as the system is in normal operation. In the hydrogenated vent header, the containment isolation valves and the pipe line that penetrates the Containment Building are tested in accordance with the procedures of Subsections 6.2.4.4 and 6.2.6.

9.3.6.5 Instrumentation Requirements

Pressure indicators are provided in the three vent headers of the Equipment Vent System.

Pressure indication and a high pressure alarm are provided for the Hydrogenated Vent Gas header. These signals are displayed in the main control room by the Main Plant Computer System (MPCS).

The containment isolation valves in the hydrogenated vent header are automatically closed by a "T" signal in the event of containment isolation, and do not open automatically when the "T" signal is reset.

The pilot-operated relief valve in the hydrogenated vent header directs radioactive gases to the PAB exhaust unit in the event of high pressure in the vent header. To inhibit the opening of this relief valve, an alarm at the MCB (at a setting lower than that of the relief valve) alerts the operator who then initiates corrective action to prevent pressure buildup in the header. A sight flow glass is used in each reactor coolant system vent line.

9.4 AIR CONDITIONING, HEATING, COOLING AND VENTILATION SYSTEMS

This section describes the air conditioning, heating, cooling and ventilation systems employed in various plant buildings and structures.

The outside ambient conditions used for design of these systems and the inside design temperatures specified for these outside ambient conditions are summarized in Figure 3.11-1.

The areas containing equipment required to cope with a Station Blackout were evaluated for the effects of loss of ventilation (see Section 8.4.4.4). These areas include the emergency feedwater pumphouse, vital switchgear rooms, battery rooms, containment structure, main control room, electrical tunnels including electrical penetration area, mechanical penetration area and main steam/feedwater pipe chases including east electrical room and west stairwell. For all of these areas, the final calculated temperature at the end of the four-hour Station Blackout coping duration was acceptable.

9.4.1 Control Room Complex Heating, Ventilation and Air Conditioning System

Seabrook Station's control room complex occupies the entire 75'-0" elevation of the Control Building (see Figure 1.2-32). The HVAC systems that service the control room complex are described below and in Section 6.4, Habitability Systems. In addition, the redundant filter systems integral to the emergency makeup air and filtration subsystem are detailed in Subsection 6.5.1, ESF Filter Systems.

9.4.1.1 Design Bases

The air conditioning, heating and ventilation system for the control room complex is designed to maintain the temperature throughout the control room complex within design limits at all times, to dilute odors, smoke and other internal air contaminants, to retain airborne particulates and to absorb radioactive iodine which may penetrate the control room during accident conditions external to the control room.

On May 21, 1991, a complete revision to 10 CFR 20 was issued. Several design bases reference the old 10 CFR 20 and specific terms or parts of the old 10 CFR 20. Design bases information provides a historical perspective of the information used to formulate a particular design. References to the old 10 CFR 20 when used in a historical or design bases context have not been changed to reflect the revised 10 CFR 20.

The cooling system for both normal and emergency plant operation is designed to maintain the control room temperature at or below design maximum temperatures (refer to Figure 3.11-1) when the outside air temperature is 88°F or lower. The heating system is designed to maintain the control room temperature at or above design minimum temperatures when the outside temperature is 0°F or above and when the control room is being supplied with 1000 cfm of outside air.

The control room complex air conditioning system is physically and operationally independent of the filtering, heating and ventilating of the remainder of the Control Building.

Exhaust fans/hoods have been installed over the chilled water condenser units to ensure that all the condenser unit exhaust heat is captured and removed from the area.

The control room HVAC equipment room is maintained at a positive pressure at least 1/8" w.g. greater than the outdoors and cable spreading room. During normal operations, this positive pressure is maintained by the normal makeup air subsystem and the exhaust and static pressure control subsystem. The exhaust control damper modulates to control the HVAC equipment room static pressure as described in Subsections 6.4.2.2 and 6.4.2.4. Under emergency conditions, the positive pressure is maintained by the emergency makeup air and filtration subsystem. The normal makeup air and air exhaust and static pressure control subsystems isolate, and the emergency makeup air and filtration subsystem actuates automatically under accident conditions (high intake radiation, "S" signal). The control room proper is maintained at a slightly greater pressure than the HVAC equipment room. Control room pressurization precludes the infiltration of hazardous contaminants.

The control room air conditioning system consists of a redundant safety related chilled water subsystem and a diverse nonsafety-related chilled water subsystem. Both of these systems use a chilled water solution with ethylene glycol to provide freeze protection. The safety related and nonsafety-related chilled water cooling coils share common safety related air handling units which supply conditioned air to the control room. Safety related exhaust fans are provided above each safety related chiller to remove heat exhausted by the chiller condenser fans during operation.

Modular microprocessor based digital control systems are provided to coordinate stand-alone operation of each chiller. The digital control system for each chiller consists of a network of modules with embedded firmware that receives analog and binary inputs from various sensors. The inputs are processed and outputs are supplied in the form of modulating voltages and contact operation to control operation of the chiller compressors, refrigerant valves and condenser fans to maintain a set evaporator leaving water temperature. The digital chiller controls also provide a high level of equipment protection functions that keep the cooling system operating safely within predetermined parameters.

During low outside ambient temperature conditions, chiller head pressure control is maintained by reducing condenser fan capacity. Condenser fans are staged based on saturated condensing temperature. Head pressure control is further enhanced on the safety related chillers by microprocessor based variable speed fan drive units, one for each cooling circuit on each chiller. These drive units modulate speed of the condenser fans in relation to saturated condensing temperature to allow stable compressor operation to 0°F. During normal plant operation the non-safety subsystem is usually aligned to provide control room cooling. One of the safety-related trains is aligned for automatic operation while the redundant train is placed in standby. The condenser exhaust fans are normally aligned for automatic operation on a demand signal for chiller operation. The safety-related train that is aligned for automatic operation has the same train designation as the control room air handling unit that is aligned to support operation of the non-safety-related subsystem.

Following a loss of offsite power, the non-safety chilled water subsystem shuts down since it is not connected to emergency power. Subsequently, an automatic start sequence is initiated for the safety related chilled water system by the emergency Diesel Generator Load Sequencer. The corresponding control room air handling unit, condenser exhaust fan and chilled water pump start prior to operation of the chiller.

In the event that the chilled water subsystem aligned for automatic operation fails to operate, operator actions will be taken to start the redundant train of chilled water equipment from the MCB. Similar actions will be taken to start one of the redundant safety related chilled water systems if the non-safety subsystem fails.

The capability for alignment of one train of the safety-related CBA subsystem for maintained operation is also provided via the controls on the Main Control Board.

No single active failure will cause a loss of both safety-related control room complex air handling units or chilled water systems. No single active failure will cause a complete loss of control room makeup air and subsequent loss of control room pressurization (as clarified in paragraph 9.4.1.2c). No single active failure will disable the normal makeup air automatic isolation function. No single active failure will cause a loss of both emergency filtration systems. No operator actions outside of the control room will be required to support alignment of redundant equipment in response to a single active failure of the control room complex air handling unit, chilled water systems or condenser exhaust fans.

Normally, the nonsafety-related system is in operation. However, the safety-related control room air conditioning system is capable of the following functions normally and following a LOCA, a safe shutdown earthquake or a tornado: condition the room air as required, distribute the conditioned air throughout the control room, filter the recirculated and makeup air of particulates and collect the spent air from the control room for reconditioning.

The control room normal makeup air subsystem is capable of performing the following functions during normal operations and following a LOCA, a safe shutdown earthquake or a tornado: maintain a positive pressure within the complex at all times (except when positive pressure is maintained by the emergency makeup air and filtration subsystem as described below) with respect to adjacent areas and the outside atmosphere to prevent the infiltration of air from local areas that could under certain circumstances contain objectionable contaminants and supply ventilation air for the occupants, isolate automatically in the presence of a high intake radiation signal or upon actuation of the emergency makeup air and filtration subsystem.

The control room emergency makeup air and filtration subsystem is capable of performing the following functions during normal operation, and following a LOCA, a safe shutdown earthquake or a tornado: maintain a positive pressure with the complex at all times with respect to adjacent areas and the outside atmosphere, supply ventilation air for the occupants, filter all makeup air and a portion of recirculated air for removal of airborne particulates and iodines, and heat the air within each filter to maintain the relative humidity less than or equal to 70 percent to optimize the charcoal adsorption efficiency.

The control room exhaust and static pressure control subsystem is capable of automatic isolation normally and following a LOCA, safe shutdown earthquake, or a tornado in the presence of a high intake radiation signal or upon actuation of the emergency makeup air and filtration subsystems.

The isolation functions for the control room normal makeup air subsystem and the exhaust and static pressure control subsystem are designed to remain functional during and after a SSE concurrent with an assumed loss of offsite power and a single active failure.

All vital components of the safety-related control room air conditioning subsystem and emergency makeup air and filtration subsystem are designed to remain functional during and after an SSE concurrent with an assumed loss of offsite power and a single active failure.

The safety-related control room complex HVAC systems are housed in seismic Category I structures designed to withstand the effects of flooding and tornado missiles except for a portion of the west makeup air intake piping. The unshielded piping associated with this intake has a low mean value probability, calculated in the range of 2×10^{-9} to 3×10^{-7} per year for tornado missile impact. The intake opening is located several feet above grade and is therefore not susceptible to the effects of flooding. Wind and tornado loadings are discussed in Section 3.3; flood design in Section 3.4; and internal and external missiles in Section 3.5. Protection against dynamic effects associated with the postulated rupture of piping is discussed in Section 3.6. Environmental design of piping is discussed in Section 3.6. Environmental design of mechanical and electrical equipment is discussed in Section 3.11.

The safety-related control room air conditioning subsystem components are ANSI Safety Class 3 and seismic Category I, except for the cooling coil filters, the unit heaters (room), and the recirculating air damper.

The nonsafety-related subsystem chilled water coiling cools are ANS Safety Class 3 and Seismic Category I. The associated piping in the mechanical room is nonsafety-related, but designed and constructed in accordance with position C.2 of Reg. Guide 1.29. The remainder of the system is nonsafety-related and non-seismically supported. The fans, dampers, damper actuators, controls and piping of the normal makeup air subsystem are ANSI Safety Class 3, seismic Category I. The fans, dampers, damper actuators, filters, vital controls, vital instrumentation, and piping/ductwork of the emergency makeup air and filtration subsystem are ANSI Safety Class 3 and seismic Category I. The filtration system also satisfies the design criteria of Regulatory Guide 1.52 as clarified in Updated FSAR Subsection 6.5.1. The redundant exhaust and static pressure control subsystem dampers, damper actuators, and vital controls required for system isolation are Safety Class 3 and seismic Category I. The control room static pressure control loop that modulates the exhaust control damper under normal conditions is nonsafety-related. Ductwork for the exhaust and static pressure control subsystem from the exhaust control/isolation damper to the tornado damper, including the redundant isolation damper, is ANSI Safety Class 3 and seismic Category I. The control room exhaust fan, the remaining exhaust and static pressure control subsystem ductwork, and the computer room air conditioning unit are nonsafety-related and nonseismic Category I.

The codes and standards used in the design, fabrication and installation of the control room air conditioning system are as follows:

a. The safety-related water chillers, safety-related chilled water pumps, safety-related cooling coils, safety-related chiller condenser exhaust fans, and safety-related backdraft dampers are in accordance with manufacturer's standards. Quality standards are maintained by the use of Appendix "B" suppliers and the "commercial grade dedication" process.

b. Chilled water piping (NNS) design in accordance with ANSI B31.1 (1987) and ASHRAE Systems & Equipment (1996)

c. The electric components, control components and overload protection systems are designed and fabricated in accordance with the codes and standards identified in Updated FSAR Subsection 8.1.5.

d. Safety-related chilled water piping design is in accordance with ANSI B31.1. Quality standards are maintained via the use of Appendix "B" suppliers and the "commercial grade dedication" process.

e. Fabrication and installation are under all applicable QA and QC standards for the safety class and seismic requirements for the system.

f. The digital chiller and variable speed fan control firmware and hardware were verified using guidance provided in the guidelines, codes and standards identified in Table 9.4-1A.

Additional codes and standards used for HVAC system components are summarized in Table 9.4-1. See Table 9.4-17 and Table 9.4-17a for control room complex air conditioning system performance information and Table 9.4-18 for the control room complex makeup air and cleanup filtration system performance information.

The digital computer based control equipment used to support operation of the safety related chillers and fan variable speed drive units were reviewed and qualified for the control room air conditioning system application. The approach emphasizes consideration of the effects of potential failure modes within the system software and hardware, as well as the potential effects of electromagnetic interference. Industry standards and guidance, licensing guidance and commercial grade component dedication procurement activities are integrated to provide reasonable assurance that the digital equipment will be highly reliable when performing the required safety functions.

EPRI reports NP-5652, TR-102348 and IEEE Standard 7-4.3.2 were applied by a third party supplier as the primary source of guidance for qualification and dedication of the chiller and variable speed drive digital controls in accordance with the requirements of 10 CFR 50, Appendix A. Applicable portions of the guidelines, codes and standards noted on Table 9.4-1A were also applied to support qualification of these components for this application. Design and performance of the chiller were verified by test, inspection or observation as part of equipment dedication to provide reasonable assurance that the equipment will be reliable in performance of the intended safety function.

The guidance provided in IEEE Standard 7-4.3.2 was used to support acceptance of the operating system embedded functions (firmware). Control system functional performance verification and validation testing and source surveillance of the original equipment manufacturer were performed to ensure reliability and dependability of the integrated chiller and variable speed drive digital control hardware and firmware.

The qualification program also included proof testing in accordance with IEEE 344 and IEEE 323, electromagnetic and radio frequency interference qualification testing in accordance with EPRI TR-102323 and mild environment qualification by analysis in accordance with IEEE 323.

9.4.1.2 System Description

The control room complex HVAC system (see Figure 9.4-1, Figure 9.4-2, Figure 9.4-3 and Figure 9.4-25) consists of the following subsystems:

Control room safety-related air conditioning subsystem

Control room nonsafety-related chilled water system

Computer room air conditioning subsystem

Control room normal makeup air subsystem

Control room emergency air makeup and filtration subsystem

Control room exhaust and static pressure control subsystem.

a. Control Room Air Conditioning Subsystem

The control room air conditioning subsystem includes both safety-related and nonsafety-related cooling subsystems. The safety-related and nonsafety-related cooling subsystems share a common recirculating air system located on elevation 75'-0" within the control room complex.

The safety-related control room air conditioning subsystem consists of two full-sized identical air cooling trains that are independently electrically powered. One train is supplied from emergency Bus A, and the other from emergency Bus B. Each train consists of:

(1) a 100% capacity electric motor-driven water chiller,

(2) two (2) 100% capacity chilled water circulating pumps,

(3) one (1) 100% capacity chiller condenser exhaust fan,

(4) a backdraft damper,

(5) a 100% capacity air handling unit located in the recirculated control room air cooling stream, and

(6) interconnecting piping, expansion tank and instrumentation and controls.

Each electric motor-driven chiller is a factory fabricated package unit consisting of two (2) equal capacity refrigerant circuits with each circuit consisting of two (2) scroll type refrigeration compressors, a shell and tube evaporator and an air cooled condenser. The water chillers are located in the Diesel Generator Building mechanical equipment room on elevation 51'-6".

The chilled water recirculating pumps are electric motor driven, and are of the centrifugal type. These pumps circulate a glycol/water mixture through an air-cooled liquid chiller. The pumps are located in the Diesel Generator Building mechanical equipment room on elevation 51'-6".

The chiller condenser exhaust fans capture the heat rejected from the chillers into the mechanical equipment room and exhausts it to the outside via exhaust ductwork. They are located in the Diesel Generator Building mechanical equipment room on elevation 51'-6".

Each air handling unit consists of a medium efficiency flat filter, a cooling coil section and a fan section. The cooling coil section houses the safety-related chilled water cooling coil as well as the nonsafety-related cooling coil. One of the two (2) air handling units is always in operation irrespective of whether the nonsafety-related chilled water system or the safety-related chilled water system is in operation.

The air handling unit with its associated safety-related refrigeration equipment is designed to produce 58.7 tons of refrigeration, and is sized to meet the design emergency conditions requiring 53.1 tons of refrigeration, during normal plant conditions, the control room air conditioning subsection can provide cooling to supplement the computer room if the computer room air conditioning unit is unavailable.

The nonsafety-related subsystem includes two chilled water pumps located in the Administration and Services Building mechanical room 1B. Each pump circulates a glycol/water mixture through an air-cooled liquid chiller located on the Administration and Services Building roof. The chilled water is then delivered to a chilled water cooling coil mounted within each of the safety related CBA evaporator fan units located in the Control Building, elevation 75 ft. mechanical room. Safety-related evaporator fan units CBA-FN-14A or 14B distribute and circulate the cooled air throughout the control room complex.

The nonsafety-related control room air conditioning subsystem will normally operate. In the event of a malfunction in the nonsafety-related subsystem, or during a loss of offsite power, one of two 100% capacity safety-related trains of control room air conditioning will be placed in service manually.

The control room is supplied with conditioned air through a sheet metal duct system that is seismic Category I supported. Air is distributed through diffusers, as necessary, to maintain design room temperature. Return air is drawn from the control room through return air registers into the plenum above the ceiling. The return air is then drawn through the plenum and passes through the return air openings in the wall between the plenum and the mechanical equipment room. The return air, together with the makeup ventilation air, is drawn through the air conditioning unit for conditioning and recirculation.

b. Computer Room Air Conditioning Subsystem

The computer room air conditioning subsystem has a recirculating air system which consists of a vertical unit located in the computer room. Conditioned air is discharged from the unit into a raised floor and then into the room through grills in the raised floor. Air is then returned through the face grills on the unit. The temperature and humidity controllers are factory installed and wired within the unit.

A glycol supply and return water system is used to remove the room heat load, using pumps and a dry cooler located on the Diesel Generator Building roof.

The control room air conditioning system ductwork contains manually controlled air dampers which in the open position permit utilization of the control room air conditioning capacity should the computer room air conditioning system be unavailable. The computer room ductwork is seismically supported, nonsafety-related.

c. Control Room Normal Makeup Air Subsystem

During normal plant operation, the control room normal makeup air subsystem is aligned to deliver approximately 1000 cfm of outside air from both remote intakes (500 cfm per intake). With one normal makeup air fan operating and its associated discharge damper open, the intake isolation valves are positioned to allow equal amounts of air to be drawn from the east and west intakes. The east air intake is protected against tornado missiles by a reinforced concrete structure (see Figure 6.4-1). A portion of the west air intake is not protected against tornado missiles (see Figure 6.4-2). However, the low effective target area results in a low mean value probability, calculated in the range of 2×10^{-9} to 3×10^{-7} per year, for tornado missile impact. The normal makeup air flows through the prefilter and heater for each emergency filter unit and discharges via an orifice plate into the HVAC equipment room. The heater for each unit operates continuously to maintain the humidity at or below 70 percent RH. The prefilters are periodically replaced when the differential pressure across the filters increases to a predetermined value, as a result of particulate buildup.

The continuous supply of makeup air to the control room HVAC equipment room maintains the complex at a positive pressure with respect to the outside and adjacent areas. This positive pressure precludes the infiltration of hazardous contaminants. The control room is maintained at a slightly greater positive pressure than the HVAC equipment room. The supply air also provides adequate air changeout to preclude the buildup of stale air and noxious odors.

In the event normal makeup air fails or is isolated for reasons other than those delineated in Subsections 6.4.3.2 and 6.4.3.3 and below, appropriate operator action will be taken to re-establish makeup air. If makeup air is lost because of fan failure, the redundant normal makeup air fan and its discharge damper will be manually actuated. If makeup air is lost because of a vital bus outage or failure, or a loss of instrument air supply to the dampers, the emergency makeup air filtration subsystem will be manually actuated.

The remote air intakes are monitored for radiation and smoke. Each intake is designed with two fully redundant radiation monitoring systems. Following an accident when high radiation is detected in either remote air intake or when the emergency makeup air and filtration subsystem fans are actuated, the normal makeup air fans automatically trip off and their associated discharge dampers automatically close. The control systems for these fans and dampers are "cross-trained." That is, the discharge damper associated with the Train A fan is controlled by the Train B control loop and vice versa. This configuration ensures isolation of the normal makeup air subsystem by fan trip and/or damper closure regardless of any single active failure.

Each intake is provided with smoke detection capability to automatically alarm and permit operator-initiated isolation of the control room normal makeup air subsystem. This isolation procedure would include manually starting the emergency cleanup filtration subsystem from the main control board, which automatically isolates the normal makeup air subsystem. The HEPA filters associated with this filtration subsystem will remove smoke from incoming air. The effected intake can then be manually isolated.

All of the active components of the normal makeup air subsystem are redundant, and all are independently powered and controlled from independent emergency buses so that no single failure will impose operational limitations.

Instrumentation and controls for the subsystem are described in detail in Subsection 6.4.6.1.

d. Control Room Emergency Makeup Air and Filtration Subsystem

Following an accident, when high radiation is detected at either remote intake, or upon generation of an ‘S’ signal, both redundant emergency makeup air fans and their associated discharge damper are automatically actuated. Although the redundant filter system fans are designed to operate coincidently and stably in their parallel configuration, Operations may, at their discretion, shut down one of the systems during the course of the accident. Each filter system may also be initiated manually upon detection of smoke in either remote intake (see Subsections 6.4.3.2 and 9.4.1.2c).

Each emergency makeup air and filtration subsystem has a nominal capacity of 1100 cfm. This capacity is comprised of 600 cfm makeup air and 500 cfm recirculation air. These system flow rates have been calculated assuming both remote intake isolation valves are open to a throttle position allowing for 300 cfm makeup air from each intake. Following an accident, a contaminated remote intake does not have to be manually isolated. Design base analyses indicate that the makeup air dilution factor (i.e., 50 percent makeup air from "clean" intake, 50 percent air from contaminated intake) and the radioactive particulate and iodine removal capacity of the filters together are adequate to maintain control room doses below allowable limits for the 30-day accident mitigation period.

The compliance of the filter systems to Regulatory Guide 1.52 is outlined in Table 6.5-2. Additional filter design details are provided in Subsection 6.5.1 and Table 6.5-5.

The gross volume of the control room complex is approximately 246,000 cubic feet. Therefore, operation of the emergency makeup air and filtration subsystem at a nominal flow rate of 1100 cfm will effectively filter the entire control room complex air in approximately 224 minutes. Instrumentation and controls for the subsystem are described in detail in Subsection 6.4.6.2.

All active components of the emergency makeup air and filtration subsystem are redundant, and are all independently powered from emergency buses and controlled so that no single failure will impose operational limitations.

e. Control Room Exhaust and Static Pressure Control Subsystem

During normal plant operation, the control room exhaust fan is operating and its discharge control damper modulates to maintain the control room complex at a pressure of at least +$^1/_8$" w.g. with respect to adjacent areas. The redundant exhaust isolation damper remains fully open.

The pneumatically-operated modulating damper in the exhaust ductwork controls the amount of air being exhausted and, thereby, maintains a positive pressure within the control room complex. The damper is under the control of three static pressure sensing devices. The first pressure sensing point for the complex is in the HVAC equipment room, which is at a slightly lower positive pressure than the remainder of the control room envelope. The mechanical equipment room, the second pressure sensing point, is kept at least $^1/_8$" w.g. above the outside atmospheric pressure and at least $^1/_8$" w.g. above the cable spreading room at all times, which is the third pressure sensing point.

Detection of high radiation in either remote makeup air intake or operation of either emergency makeup air and filtration subsystem fan will automatically isolate the exhaust and static pressure control subsystem. Under emergency conditions the exhaust subsystem remains isolated at all times.

During normal operation, 1000 cfm of makeup air will be delivered to the control room complex. Approximately 145 cfm will be exfiltrated and the remaining 855 cfm will be exhausted. Under emergency conditions, approximately 600 cfm of makeup air will be delivered to the control room complex all of which will be exfiltrated.

The isolation control function for each exhaust isolation damper is powered from an independent emergency bus. No single active failure will preclude the automatic isolation of the exhaust and static pressure control subsystem.

Additional instrumentation and control details are provided in Subsection 6.4.6.3.

9.4.1.3 Safety Evaluation

The operation of all HVAC mechanical equipment is controlled and monitored in the control room complex. Additional details on system instrumentation and controls are provided in Subsection 6.4.6.

Control room habitability under all accident conditions is assured by a continuous supply of makeup air and resultant pressurization of the complex. If control room pressurization is temporarily lost under normal/nonaccident conditions, manual actuation from the control room of the emergency makeup air and filtration subsystem will re-establish positive pressure using the bypass piping. The remote location of the air intakes from each other and from potential radiological release sources provides dilution of contaminants in the makeup air which, in conjunction with the system's particulate and iodine filtration efficiency, satisfies control room dose criteria specified in 10 CFR 50, Appendix A, GDC 19 and Section 6.4 of the Standard Review Plan.

All active components in the normal makeup air subsystem, emergency makeup air and filtration subsystem, and exhaust and static pressure control subsystem, except the exhaust fan, are designed ANS Safety Class 3 and seismic Category I. The exhaust fan is designed NNS.

The filtration systems, including associated fans and dampers, are designed as Engineered Safety Features (ESF) in accordance with Regulatory Guide 1.52 (as clarified in Subsection 6.5.1) and Subsection 6.5.1 of the Standard Review Plan. The filter trains are fully redundant.

All redundant active electrical components are powered by separate and independent trains of emergency power from the diesel generators. Pneumatically-actuated system dampers are designed to fail in the safe position as follows:

Normal Makeup Air Discharge Damper	(CBA-DP-53A)	Fail Closed
Normal Makeup Air Discharge Damper	(CBA-DP-53B)	Fail Closed
Exhaust and Static Pressure Control Damper	(CBA-DP-28)	Fail Closed
Exhaust Isolation Damper	(CBA-DP-1058)	Fail Closed
Emergency Makeup Air Discharge Damper	(CBA-DP-27A)	Fail Open
Emergency Makeup Air Discharge Damper	(CBA-DP-27B)	Fail Open

In addition, the piping that bypasses the normal makeup air fans and dampers is provided with redundant backdraft dampers configured in parallel. This design ensures that an emergency makeup air flow path is available in the event one of the backdraft dampers fails to open upon actuation of the emergency makeup air fans.

Failure of a condenser exhaust fan backdraft damper to open is detected by high exhaust fan differential pressure. The exhaust fan and associated chiller are tripped to prevent the release of excessive heat, which could affect other HVAC systems.

The redundant and fail-safe damper design or low flow trips ensures that the system will perform its safety-related functions regardless of any single active failure. The system is designed to satisfy 10 CFR 50, Appendix A, criteria for single active failure.

The motors for the normal and emergency makeup air fans are designed Class 1E. The electric air heaters associated with each filter are also Class 1E. All electrical, instrumentation, and control systems that perform vital control functions are designed Class 1E in accordance with IEEE Standard 279-1971, and otherwise satisfy existing commitments in Chapters 7 and 8 of the Updated FSAR.

The makeup air duct upstream of the redundant emergency filters and external to the control room complex envelope is heavy-wall carbon steel pipe designed to remain intact and functional following a seismic event. The filter housings, discharge ductwork, and all other passive system components are also designed to remain intact and, except for some instrumentation which does not provide vital control or monitoring, remain functional following a seismic event. All portions of the makeup air system external to the control room complex envelope are designed to minimize inleakage.

All safety-related active and passive components of the system are contained in missile-protected buildings or are underground except for a portion of the west makeup air intake. The unshielded piping associated with this intake has a low mean value probability, calculated in the range of 2×10^{-9} to 3×10^{-7} per year, for tornado missile impact. No internally generated missiles which could impair the system's ability to perform its safety-related functions are credible.

The safety-related control room air conditioning system's water chillers, cooling coils, circulating pumps, air handling unit fans, condenser exhaust fans, and filter are redundant and are independently supplied with power so that no single failure will impose operational limits. The heating system's room unit heaters are not required to maintain the operation of the control room; therefore, redundant unit heaters are not provided. Power is supplied to these unit heaters from nonsafety-related busses.

The nonseismic components or systems located in the control room complex are located so that if failure due to a seismic event should occur, no damage will occur to safety-related components, equipment, or systems located in the control room complex. Nonseismic components located adjacent to safety class components have been analyzed to assure that they will not overturn or fail in such a way as to damage safety class components. Nonseismic, nonsafety-related components are electrically isolated and mechanically independent from safety-related components.

Both the nonsafety-related water chillers and the safety-related water chillers are provided with protective devices to prevent high refrigerant discharge pressure.

Further, the nonsafety-related water chillers are located outside, on the roof of the Administration Building. Any refrigerant discharge from them has no effect on control room habitability. The safety-related water chillers are located in the diesel generator mechanical equipment room outside the control room pressure envelope. Therefore, any refrigerant discharge from them, similarly, has no impact on control room habitability. Additionally, a conservative analysis has been performed to show that in the unlikely event that the entire refrigerant inventory of an operating safety-related chilled water train escapes, the resulting refrigerant concentration in the equipment room (which is outside the control room pressure envelope) is well within acceptable limits.

The air handling unit discharge damper, the machinery room recirculation damper and the makeup air fan discharge dampers which could degrade system performance if proper operation did not occur are equipped with handwheels or jacks, or are readily accessible for proper operation.

The outside wall opening in the control room mechanical equipment room for the control room static pressure and exhaust system is protected by a tornado damper as described in Section 3.3.

There are no high or moderate energy lines which could, upon failure, affect the performance of the control room complex systems.

9.4.1.4 Inspection and Testing Requirements

Air systems ductwork is leak tested during installation. During system preoperational testing, air system balancing and adjustment to design air flow is accomplished and operability, control, and alarm functions are verified. Subsection 14.2.11 further describes system testing requirements.

Initial and periodic filter testing of the Emergency Filtration Systems and associated components are conducted in accordance with Regulatory Guide 1.52.

9.4.2 Fuel Storage Building Heating and Ventilation System

The Fuel Storage Building Heating and Ventilation System consists of a normal heating and ventilation subsystem and an emergency air cleanup subsystem. The normal heating and ventilation subsystem is described here; the emergency air cleanup subsystem is further discussed in Subsection 6.5.1.

9.4.2.1 Design Bases

The normal Fuel Storage Building heating and ventilation subsystem (see Figure 9.4-4) is designed to: (1) distribute filtered outside air throughout the Fuel Storage Building for removal of various heat loads in the summer and to offset building heat loss in the winter and (2) limit tritium concentrations in the building to the maximum permissible concentration (MPC) during normal operation to assure personnel access and safety.

Refer to Updated FSAR Figure 3.11-1 for information on environmental conditions of various areas for the Fuel Storage Building.

The normal ventilation subsystem is designed to operate in conjunction with the emergency air cleanup subsystem whenever irradiated fuel not in a sealed cask is handled.

All components of the normal Fuel Storage Building heating and ventilation subsystem are classified as nonsafety-related, with the exception of the supply air dampers which are Safety Class 3 and seismic Category I, and the duct through the containment enclosure which is Safety Class 2 and seismic Category I.

Codes and standards for the subsystem components are presented in Table 9.4-1.

9.4.2.2 System Description

The normal heating and ventilation subsystem, see Figure 9.4-4, is comprised of filters, dual purpose chilled water cooling/hot water heating coils for summer cooling or winter heating, supply air fans, chillers and a ducted distribution system with parallel-path supply dampers which are a part of the Primary Auxiliary Building Ventilation System (see Subsection 9.4.3). A hot water unit heater system, which is supplied with hot water from the Primary Auxiliary Building Hot Water Heating System, is also provided. The system is designed to maintain inside design temperatures suitable for equipment and personnel. The Fuel Storage Building Heating and Ventilation System performance parameters are listed in Table 9.4-16.

Filters for the normal ventilation supply air are designed for over 80 percent efficiency per NBS Dynamic Test using Cottrell dust and over 200 gr/sq. ft. dust holding capacity per NBS Dynamic Test.

The normal heating and ventilation subsystem employs two slotted exhaust intake hoods designed to sweep the pool surface in order to capture the dilute vapors emanating from the spent fuel pool. The entrained air and vapor are ducted to a vaneaxial fan, normal ventilation exhaust air isolation damper and from there to the unit plant vent.

Two basic modes of air handling are available, as discussed below. For all modes, the operation of the mechanical equipment is controlled and monitored from the plant unit control room.

a. Normal Once-Through Supply Exhaust Ventilation Mode

During normal operation, filtered outside air is circulated through the Fuel Storage Building by the normal ventilation system, with the exhaust air discharged from the building via the unit plant vent. Filtering of the exhaust air is not normally performed.

b. Fuel Handling Mode

The fuel handling mode is used any time irradiated fuel not in a sealed cask is handled. In the fuel handling mode of operation, the normal Building Exhaust System is isolated prior to initiation of fuel handling operations by closing the normal exhaust isolation damper and stopping the normal exhaust fan. The Fuel Storage Building is maintained at a negative pressure of 0.25" w.g. or more (negative). This is achieved by exhausting air from the building at a higher rate than directly supplied from the PAB Supply Air System. Maintaining the building at a negative pressure will minimize, or eliminate, the leakage of radioactive material to the environment in the event of an accident (see Subsection 15.7.4, "Fuel Handling Accidents"). The exhaust filter trains are redundant, with one unit required to operate in the event of an accident.

The redundant filter units and their respective components are fed from independent power sources so that no single failure would prevent the obtaining and maintaining of the negative pressure. The static pressure control for the parallel supply system dampers are provided with manual override provisions to allow the operator to control the damper position and the building pressure if required.

Operation of the Fuel Storage Building Ventilation System is further discussed in Subsection 6.5.1.

The system fans and dampers are controlled from the main control room. Flow, pressure, temperature, filter differential pressure and moisture content measurements have been provided in each train. Alarm of off-normal condition of any of the above parameters are provided in the main control room. Instrumentation and essential parameter monitoring is further discussed in Subsection 6.5.1.5b. Airborne gross radiation level measurements are provided in common discharge header, as discussed in Section 12.3.

See Table 9.4-1 for industry standards and codes for HVAC system components; see Table 9.4-16 for Fuel Storage Building Heating and Ventilation System performance parameters.

9.4.2.3 Safety Evaluation

The safety-related portions of the Fuel Storage Building Heating and Ventilating Systems are located in a seismic Category I structure and are tornado missile and flood protected.

9.4.2.4 Inspection and Testing Requirements

During preoperational testing the Fuel Storage Building Heating and Ventilation System is balanced and adjusted to design air flow, and system operability, control and alarm functions are verified.

9.4.3 Primary Auxiliary Building Heating and Ventilating System

9.4.3.1 Design Bases

The function of the normal Heating and Ventilating System for the Primary Auxiliary Building (PAB) is to provide sufficient circulation of filtered outside air for removal of heat generated by lighting and equipment in the summer, and to offset building heat losses in the winter, in the rooms and areas listed on Figure 3.11-1 for the Primary Auxiliary Building.

The PAB Ventilation and Heating System also supplies conditioned air to the Fuel Storage Building (FSB) and makeup to the containment enclosure area (CEA). Under normal operating conditions, the charging pump rooms are exhausted through this heating and ventilating system. Descriptions of ventilation in these areas are included in Subsections 9.4.2 and 9.4.6.

The normal Heating and Ventilating System, equipment and ductwork is non-seismic Category I and has no safety classification, with the following exceptions: the ductwork passing through the containment enclosure providing conditioned air to the FSB, the containment enclosure makeup air and exhaust air isolation dampers, and the exhaust ductwork from the charging pump rooms are all seismic Category I, Safety Class 2. The PCCW pump area and the boron injection equipment area are provided with a Safety Class 3, seismic Category I ventilation system for emergency use should the normal ventilation system not be available.

The ventilating system is designed to control air flow from areas of low potential airborne radioactivity toward areas of higher potential airborne radioactivity for filtration prior to exhausting to the unit plant vent for atmospheric dispersion.

The PAB HVAC systems are housed in seismic Category I structures.

Design for wind and tornado loading is discussed in Section 3.3; flood design in Section 3.4; design for internal and external missiles in Section 3.5; protection against the dynamic effect of a postulated pipe rupture in Section 3.6; environmental design of piping in Section 3.6; environmental design of mechanical and electrical equipment in Section 3.11, and radiation monitoring in Section 12.3.

The systems are designed and constructed in accordance with AMCA, ASHRAE and SMACNA Standards. Applicable codes and standards are listed in Table 9.4-1.

9.4.3.2 System Description

The PAB Heating and Ventilation System is shown in Figure 9.4-5, Figure 9.4-6, Figure 9.4-7, Figure 9.4-8, Figure 9.4-9 and Figure 9.5-10. This system contains both safety and nonsafety-related equipment, as listed in Table 9.4-2 and Table 9.4-3.

Two air handling systems serve this building. One system is a once-through supply/exhaust system for ventilation of normally clean areas. The second system is a filtered exhaust system used to collect air from potentially contaminated areas in the PAB and CEA, while maintaining these areas at a slight negative pressure.

a. PAB Supply and Unfiltered Exhaust System

This system provides 100 percent outside air to the PAB using fans located in an equipment room on the 53'-0" level. This incoming air is filtered and either cooled or heated, as per summer or winter months, then distributed through ductwork to various areas within the PAB, the Fuel Storage Building (FSB) and the containment enclosure area.

In winter, the outside air is heated by a bank of dual purpose chilled water cooling and hot water heating coils after passing through louvers and roll-type filters. The water temperature for the main hot water heating coils is controlled by thermostats mounted at Elevation 25'-0". The heating coils are supplied with hot water/glycol from a closed loop parallel pump circulating system utilizing a common steam/hot water converter. The Closed Loop Circulating System for the main heating coils is comprised of three pumps, one for each bank of heating coils and one reserve pump, each manually controlled locally. Each pump once started, runs continuously. Heating equipment is described in Table 9.4-2.

In summer, the outside air is cooled by the same bank of dual purpose chilled water cooling/hot water heating coils after passing through louvers and roll-type filters described above. The chilled water/glycol temperature is controlled by the temperature sensor located in the parallel closed loop chilled water/glycol pump circulating system using redundant air cooled packaged liquid chillers. These two chillers are located on the roof of the Waste Processing Building. The air temperature sensor located at the PAB supply air fans discharge header modulates a 3-way valve to control the chilled water to the chilled water cooling coils. The chiller, the pump, and the isolation valves are manually operated to preclude the inadvertent operation of both the chilled water cooling and the Hot Water Heating System simultaneously. This equipment is described in Table 9.4-2.

The PAB Ventilation Air Supply System has three 55590 cfm (50 percent capacity) centrifugal fans, of which two are in operation, while the third is in standby. These fans are equipped with backdraft dampers so that the discharge air from the active fans will not be recirculated through the inactive fan. The fans are manually controlled from the main control room panel, CP-23.

During normal operating mode, two fans deliver supply air in the manner of: (a) 56,780 cfm to PAB areas, (b) 31,000 cfm to FSB areas and (c) 23,400 cfm to containment enclosure for makeup. During refueling mode, these fans deliver supply air in the manner of: (a) 56,780 to PAB areas, (b) 11,000 cfm to FSB areas, (c) 23,400 cfm to containment enclosure for makeup and (d) remaining 20,000 cfm is relieved into supply fan suction by manual manipulation of a bypass branch damper.

PAB supply air pressure conditions are monitored at the discharge of the supply fans. In the event of a low pressure alarm indicating reduced flow, the operator will start the standby fan. A high pressure alarm, indicating a downstream damper closing or similar malfunction, will allow the operator to evaluate the malfunction and take corrective action.

The nonfiltered exhaust system exhausts air via a duct system from those areas in the PAB not listed in Subsection 9.4.3.2b as being served by the Filter Exhaust System. The Nonfiltered Exhaust System uses two of three exhaust fans and discharges to the plant vent. Each exhaust fan will deliver one-half of the total required exhaust air capacity. With two fans operating, the third becomes a standby that is controlled by the operator from the main control panel, CP-23. The operator is required to start the spare fan whenever a low pressure alarm condition exists.

High discharge air pressure of the nonfiltered exhaust system fans is alarmed. Should this condition occur, the operator will evaluate and determine what corrective action must be taken.

Redundant dampers are installed in the supply and exhaust ducts between the PAB and the containment enclosure area to permit isolation of the CEA in the event of a loss-of-coolant accident (LOCA) or failure of the PAB supply/exhaust system. In the event of a "T" signal, the supply and exhaust isolation dampers on the containment enclosure area Elevation 25'-0" will automatically close.

b. PAB Filtered Exhaust System

The PAB normal filtered exhaust system compliance to Regulatory Guide 1.140, Rev. 1, October 1979, is outlined in Table 9.4-20.

The Filtered Exhaust System draws air through a filter train from the following PAB areas which have the potential for becoming contaminated:

1. Charging pump rooms
2. Valve aisle
3. Chemical volume control tank area
4. Sample heat exchanger room
5. Fume hood
6. Letdown heat exchangers and filter cells
7. Pipe tunnel area
8. Degasifier area.

This system exhausts the air via a duct system through a backdraft damper, then through one of two fans which discharge to the plant vent.

This system is also manually controlled from the main control panel, CP-23. The operator selects which of the two redundant fans to operate, the discharge damper opens, and when the damper is proven open the fan will operate.

An abnormal air pressure differential across the filter train and a high temperature within the carbon adsorber section of the train are alarmed. In addition, the discharge air flow from the filter train is monitored at the control panel. The CEA and PAB ventilation system is alarmed to indicate if either or both of the supply fans have failed, or that the operating filter system fan has failed. An indication of failure of the operating filter system fan will automatically start the standby fan.

The filter train consists of a sheet metal housing containing a roll-type prefilter, medium efficiency filter, HEPA filter and a carbon adsorber section. This equipment and the associated fans and dampers are described in Table 9.4-3.

In the event of a LOCA or a loss of the PAB filtered exhaust system, dampers will isolate the CEA from the PAB. The duct isolation dampers for the CEA/PAB are arranged in series for redundancy; one within the PAB, the second in the CEA for both the supply and exhaust ducts. Upon receiving a protective "T" signal, all four isolation dampers will automatically close. In the unlikely event that the operating PAB filtered exhaust fan fails or a loss of makeup air from the PAB supply fans occurs, a 120-second delay will occur before the PAB isolation dampers will close to allow the standby filtered exhaust fan to start.

The filter train and associated fans are housed within a room which has its own ventilation and heating systems. Ventilation is provided through redundant power roof ventilators and redundant operable outside air louvers. The room is heated in winter by hot water unit heaters operating from a closed loop system.

The heating system equipment is described in Table 9.4-2. Each pair of unit heaters is connected to thermostats located in the room which will operate the unit heater fans to maintain the room temperature above minimum design requirements.

The unit heaters are supplied with hot water/glycol from a closed loop system using the same steam/hot water converter as the PAB main hot water heating coils. One centrifugal pump provides circulating water to all of the unit heaters within each room. The pump is started manually from the main control panel and runs continuously.

Control of the power roof ventilators and louvers is manually from the main control panel, CP-23, or automatically by thermostats located in the filter room. The louvers will open when the room temperature reaches the lower setpoint, the fans will start when the room ambient temperature reaches a higher setpoint. Since the louvers and power roof ventilators are 100 percent redundant, a single failure will not preclude adequate ventilation.

c. PCCW and Boron Injection Pump Area

The PCCW and boron injection pump area has redundant, automatically controlled auxiliary supply fans to ensure that the temperature in this area does not exceed design limits should the main PAB system fail. Normally, air is supplied and exhausted using the main PAB system. The fans and associated redundant supply and exhaust dampers are controlled by local thermostats. Abnormal low and high temperature conditions are alarmed on the main control panel.

The performance parameters for the PAB HVAC systems are described in Table 9.4-2. These fans, and associated automatic dampers, are ANSI Safety Class 3, seismic Category I. Motors are Class 1E.

When the temperature, as sensed by a thermostat within the PCCW/boron injection pump area, exceeds the lower setpoint, one each of the two supply and exhaust dampers will open; the fan will start when the dampers are fully open. Should the temperature reach the upper setpoint, the second fan will operate automatically in the same manner as the first. Both fans are powered from redundant emergency power supplies.

Following a loss of offsite power, both fans will be sequenced on emergency power supplies.

The fans may be controlled manually from the main control board (MCB) or automatically, as described above, by setting one or both of the control switches on the MCB in auto position.

d. Boric Acid Tank Area

The boric acid tank area (BATA) ventilation and heating systems are shown on Figure 9.4-7. Ventilation air is continuously supplied from the main PAB supply air system via ductwork to the BATA, maintaining the area at a maximum 104°F temperature.

Winter ambient design temperatures are controlled by two 100 percent redundant electric unit heaters. The area temperature is maintained above minimum design requirements during the winter. Locally mounted thermostats in the BATA automatically control the unit heaters.

9.4.3.3 Safety Evaluation

The safety-related PCCW/boron injection pump area auxiliary fans are powered from redundant trains, A and B, so that a failure of a single active component will not render the safety-related system inoperative, resulting in the loss of an Engineered Safety Feature. Redundant isolation dampers are provided in safety-related systems to ensure system performance.

The remaining PAB ventilation and heating systems have no safety design bases; therefore, they are not evaluated.

Air flow patterns are maintained with back-draft dampers, balancing dampers, air locks and exhaust fans to ensure that the building air flow is from clean areas to higher radioactivity areas. Redundant fans are provided to ensure that a single component failure will not prevent the systems from operating.

Normal operation of the supply and unfiltered exhaust air system could be affected in the event of a high or moderate energy pipe rupture. This system, however, services no essential equipment.

The safety-related auxiliary fans associated with the PCCW and boron injection equipment area are installed in an area where they cannot be damaged by a high or moderate energy line break.

The PCCW and boron injection equipment area auxiliary fans outside air openings are protected against missiles by drawing air into the fans through the outside air louvers. The exhaust air dampers for this system are protected against missiles by a concrete shield.

The following openings are protected by tornado dampers:

a Outside air supply to mechanical equipment room at floor elevation 53'-0"

b. Outside air intake and exhaust openings for auxiliary supply ventilation system in the primary component cooling pump area at floor elevation 25'-0"

c. Outside wall penetration at PAB exhaust duct from mechanical equipment room at floor elevation 53'-0"

d. Intakes to filter train in filter room at floor elevation 81'-0"

e. Roof exhaust opening at roof elevation 81'-0".

In safety-related areas, and in areas where collapse of the ductwork might result in an unfiltered release of radioactive contaminants, the ductwork has been designed to prevent its collapse during a design basis seismic event.

The safety evaluation of the PAB filter exhaust system portion for the containment enclosure area is described in Subsection 9.4.6.3.

9.4.3.4 Inspection and Testing Requirements

During the preoperational test program, the Primary Auxiliary Building Ventilation and Heating System is balanced and adjusted to design air and water flows. System operability, controls, and alarm functions are verified. Initial and periodic tests of the filter system are conducted in accordance with Regulatory Guide 1.140.

9.4.4 Waste Processing Building HVAC Systems

The Waste Processing Building (WPB) normal heating, air conditioning and ventilating system provides filtered, outside air, heated as required, to ventilate the building in accordance with the established design limits for all the areas within the Waste Processing Building.

9.4.4.1 Design Bases

The function of the WPB normal heating, air conditioning and ventilating system is to provide outside air for summer ventilation and removal of heat generated by equipment and to maintain temperatures within design limits.

The carbon delay beds and the waste solidification control room are provided with individual air conditioning systems. The boron waste storage tank area and the refueling water storage tank area require only summer ventilation and are therefore provided with separate outside air intakes and exhaust fans. The steam generator blowdown recovery area, the west mechanical equipment room, and the asphalt storage room contain electric unit heaters as well as separate outside air intakes and exhaust systems. All remaining areas are ventilated by either the WPB Main Filtered Air Supply System or the Waste Solidification Filtered Air Supply System.

Table 9.4-4 lists the normal conditions for the individual areas of the WPB.

The WPB ventilation systems function so that the ventilation air is controlled to flow from areas of low potential radioactivity toward areas of higher potential radioactivity, and then exhausts to the unit plant vent for atmospheric dispersion. Radioactivity releases are maintained within the limits of the Technical Specifications.

The ambient carbon delay bed areas are nonsafety-related. However, the ductwork in those areas is supported in such a manner to prevent its falling during an SSE. The other areas of the WPB are also not safety-related and the ductwork has no safety classification and is not seismically supported.

All of the systems are designed and constructed in accordance with AMCA, ASHRAE and SMACNA standards. The applicable codes and standards are listed in Table 9.4-1.

9.4.4.2 System Description

The WPB Heating, Air Conditioning and Ventilation Systems are shown on Figure 9.4-11 and Figure 9.4-12. The equipment is described fully in Table 9.4-5 and Table 9.4-6.

a. WPB Ventilation and Heating

The WPB ventilation and heating system consists of two centrifugal supply fans, each rated at 64,100 cfm capacity. Outside air enters the building through louvers at Elevation 86'-0", is drawn through a roll filter and hot water/glycol heating coil (for winter heating), and discharged into a ductwork distribution system to various areas of the building.

The waste solidification area ventilation and heating system consists of a centrifugal supply fan rated at 30,000 cfm capacity with inlet vane control to permit 100 percent and approximately 50 percent capacity operation. Outside air enters the building at Elevation 86'-0", is drawn through a roll filter and hot water/glycol heating coil (for winter heating). The air is then discharged into a ductwork distribution system to various areas of the building, primary distribution is in the waste solidification area.

The air supplied to the waste gas compressor areas and the hydrogen surge tank cubicles is sufficient to dilute the concentration of radioactive isotopes released below that required in 10 CFR 20 for the waste gas compressor cubicle and below the lower flammable limit for the hydrogen surge tank cubicle and the waste gas compressor cubicle. A larger quantity of air is exhausted from these areas than is supplied, resulting in their being maintained at a negative pressure.

The supply fans are manually controlled from a local control panel and are interlocked with the main exhaust fans. A specific exhaust fan must be in service to operate the corresponding supply fan to maintain a preferred direction of air flow.

During winter, the outside air is tempered by hot water/glycol heating coils to maintain the WPB indoor temperature, with the exceptions shown in Table 9.4-4, at or above the design minimum temperature. Each of the two heating systems consists of finned-tube, hot water/glycol coils, associated pumps and piping, and a steam-to-water/glycol converter.

Four exhaust systems are used as part of the building normal exhaust system. Three of the normal exhaust systems are similar in that they do not filter the exhaust air before discharging to the plant vent. The fourth exhaust system collects air from areas which, because of possible airborne contamination, require filtration before releasing the exhaust air to the plant vent.

Three booster fans in the exhaust systems noted above function to prevent excessive negative pressure in the plenum area containing the building exhaust fans. The booster fans return the exhaust air to a plenum or, in the case of the filtered system, to the filter unit. The filter unit consists of a roughing (roll) filter, pre-filter and an absolute filter as described in Table 9.4-5. Differential pressure across each element of the filter unit is indicated locally, and abnormal pressure differential across the filter unit is alarmed on the main control board (MCB). The exhaust air is then picked up by the main exhaust fans and discharged to the plant vent. Each of the main exhaust fans are sized for 50 percent of the total normal exhaust requirement, 160,200 cfm.

The compliance of the WPB filtered exhaust system to Regulatory Guide 1.140, Rev. 1, October 1979, is outlined in Table 9.4-21.

These exhaust fans are provided with inlet vane dampers which are controlled to maintain a constant negative pressure within the fan plenum.

b. Carbon Delay Bed Areas

Ventilation air is provided to these areas from the main supply system. This air is then exhausted to the building exhaust system, preventing exfiltration. See Table 9.4-5 for a description of the equipment.

In addition to the main supply system, two direct expansion refrigeration air conditioning units are available to be used to control the temperature environment of the carbon delay bed areas, when needed. Each unit is located outside the conditioned space at Elevation 64'-0", and air is supplied and returned through ductwork.

c. Steam Generator Blowdown Recovery Building

A power roof ventilator, in conjunction with an outside operable wall louver, is used to limit the temperature in this area. A space-mounted thermostat will automatically open the louver and start the power roof ventilator. Four electric unit heaters provide heat for the area.

d. Refueling Water Storage Tank and Reactor Makeup Water Storage Tank Area

Power roof ventilators, in conjunction with outside wall operable air louvers, are used to limit the temperature in these areas. General area heating is not provided since the tanks are heated by steam, as explained in Subsections 6.2.2 and 9.2.7. Should a fan failure or loss of power to the fans occur, then the adjustable louvers will move to the open position to reduce the heat load of the area by natural convection.

e. Hydrogen Surge Tank Area

Under normal operating conditions, air is drawn into the hydrogen surge tank area by the main building exhaust fan system. Upon detection of a hydrogen concentration in excess of 2.0 percent in the area, a hydrogen detector within the area will automatically start a centrifugal fan located at Elevation 86'-0". When the fan starts, an outside air damper located in the hydrogen surge tank area opens and the hydrogen-air mixture in the space is exhausted to the atmosphere.

f. Boron Waste Storage Tank Areas

Power roof ventilators in conjunction with outside wall operable air louvers are used to limit the temperature within each of the two boron waste storage areas. Each fan/louver combination is controlled from a locally mounted manual control switch. No heat is provided in this area.

g. Elevator Equipment Room

Normally, a small amount of air (420 cfm) is diverted from the main ventilation supply system to the elevator equipment room which then exfiltrates into the main equipment area at Elevation 86'-0". A space-mounted thermostat will automatically start a power roof ventilator allowing an outside air louver to open to provide additional ventilation if necessary.

h. Waste Solidification Control Room

A direct expansion split system consisting of an outdoor air-cooled condensing unit and an interior air handling and evaporator coil unit provides the required cooling. Ventilation air is supplied to the air handling unit through the building air supply system and is exhausted through the waste solidification area exhaust system.

i. Asphalt Storage Room

Ventilation is provided by a fixed wall louver. Outside air enters through the louver into a package air handling unit consisting of dampers, filter and fan. Air is exhausted by a gravity roof ventilator. Heating is provided by two electric unit heaters.

j. West Mechanical Equipment Room

A power roof ventilator, in conjunction with an outside operable wall louver, is used to limit the temperature in these areas. A space mounted thermostat will automatically open the louver and start the power roof ventilator. Two electric unit heaters provide heat for this area.

k. Centrifuge Room Filter, F-174

This filter is located in the HVAC exhaust line from the centrifuge room, and is designed to trap resin fines which could escape from the centrifuge room. The discharge is directed to the building filtered exhaust system and from there to the plant vent.

9.4.4.3 Safety Evaluation

Failure of the nonsafety-related air conditioning systems servicing the carbon delay bed areas may result in a reduction in the adsorbent quality of the carbon delay beds. However, this will not result in an increase in the release level at the plant vent since the radioactive gases will be recirculated, or the system shutdown, if necessary.

None of the systems (supply and exhaust air, filter, air conditioning and heating) have safety design bases; therefore, they have not been safety evaluated.

Air flow patterns are maintained with backdraft dampers, balancing dampers and interlocked supply and exhaust fans to insure that the building air flow is from clean to potentially contaminated areas.

Discussions relative to the possibility of ground level release through the building, as well as the possibility of an H_2 explosion causing releases, are found in Subsection 15.7.1.

9.4.4.4 Inspection and Testing Requirements

During the preoperational test program, the Waste Processing Building HVAC systems are balanced and adjusted to design air flows. System operability, controls and alarms functions are verified.

Initial and periodic testing of the filter unit is performed in accordance with Regulatory Guide 1.140 requirements.

9.4.5 Containment Structure Heating, Cooling and Purge System

This system is comprised of the following subsystems:

- Containment structure cooling subsystem
- Containment structure recirculating filter subsystem
- Containment structure online purge subsystem
- Containment structure air purge and heating subsystem
- Control rod drive mechanism cooling subsystem
- RCA Tunnel Exhaust System.

9.4.5.1 Design Bases

a. General

Except for the containment structure recirculating filter subsystem fans, dampers and ductwork, none of the above subsystems are required for safe shutdown.

b. Containment Structure Cooling Subsystem

1. The containment structure cooling subsystem is designed to maintain the normal ambient air temperature in the containment structure at or below 120°F.
2. The containment structure cooling subsystem also functions to prevent the concrete temperature in the area of the reactor supports from exceeding 150°F, and the neutron detector cavity from exceeding 135°F during normal operation.
3. The containment structure cooling subsystem cooling units are designed against overturning and structural failure during an SSE.

c. Containment Structure Recirculating Filter Subsystem

1. This subsystem is normally used to filter contaminated air within containment prior to personnel entry, and whenever it is desired to reduce airborne particulate contamination and radioactive iodine. The filter subsystem, when operated in conjunction with the pre-entry purge subsystem, reduces the airborne iodine to an acceptable level, permitting access to containment within 24 hours after the reactor is shutdown.

2. In a recirculating mode, the filter section is bypassed and the redundant fans, dampers and ductwork provide containment atmospheric mixing to prevent excessive hydrogen stratification.

3. The fans, dampers and ductwork for the subsystem are ANS Safety Class 3, seismic Category I. The filter unit has no safety-related function and is not seismic Category I.

d. Containment Structure Online Purge Subsystem

1. The containment online purge subsystem provides 1000 cfm of filtered and heated air (when required) for purging the containment area during normal operation.

2. The containment structure online purge subsystem in conjunction with the containment structure recirculation filter system is designed to reduce the airborne activity levels in the containment below the limits specified in 10 CFR 20, Appendix B, Table 1, Column 1.

e. Containment Structure Air Purge and Heating Subsystem

1. The refueling purge and heating subsystem supplies ventilation air (and heat) to maintain tritium within containment at acceptable levels during refueling. Sufficient heat is supplied to maintain an ambient temperature of 50°F.

2. The pre-entry purge subsystem, operating in conjunction with the containment recirculation filter subsystem, will reduce the airborne activity level within the containment below the levels specified in 10 CFR 20, Appendix B, Table 1, Column 1 within 24 hours following reactor shutdown.

f. Control Rod Drive Mechanism Cooling Subsystem

The control rod drive mechanism (CRDM) cooling subsystem is designed to induce supply air into the CRDM shroud at or below 120°F.

g. RCA Tunnel Exhaust System

The RCA Tunnel Exhaust System in conjunction with the RCA Tunnel Heating and Ventilation System normally maintains the RCA Tunnel pressure to meet the ventilation design bases described in Subsection 12.3.3.1.

9.4.5.2 System Design

Design and operating parameters for the containment structure heating, cooling and purge system are summarized in Table 9.4-7.

a. Containment Structure Cooling Subsystem

The containment structure cooling subsystem is shown in Figure 9.4-13. The subsystem consists of six fan-coil units, including one standby unit located at elevation 0'-0" within the containment. The five normally operating units provide sufficient cooling to maintain the space temperature at or below the maximum design condition. All units are identical, each consisting of a double-wall-insulated steel housing containing a centrifugal fan, a discharge damper, and two banks of cooling coils at opposite ends of the housing.

Three of the six cooling units have 2-speed motors, designed to operate at one-half normal speed during the containment structural integrity test and the containment leak rate test.

The six cooling units are evenly divided, three being powered from electrical Train A emergency bus A and three from electrical Train B emergency bus, with at least one two-speed motor-equipped unit on each train. Each of these trains also powers a primary component cooling water pump which supplies cooling water. The cooling coils for the cooling units are supplied from the same loop of the Primary Component Cooling Water (PCCW) System as the electrical power supply, i.e., PCCW loop A, Train A; PCCW loop B, Train B. There are no automatic control valves for the cooling coils; therefore, a constant water supply is maintained to each unit, including the standby. The water flow rate to each unit is 330 gpm at 85°F.

Recirculated air is cooled and discharged from the five operating units into a common sheet metal ductwork header and distributed throughout the containment, as shown on Figure 9.4-13. Reverse air flow is prevented in the standby unit by the automatic closing of its backdraft (discharge) damper.

The reactor cavity, supports and neutron detectors are cooled by ducting 25,400 cfm of air from the containment structure cooling units, with the cooled air divided as follows: 3500 cfm through each of the four supports, 400 cfm total for the neutron detectors, 1000 cfm to the cavity below the reactor, and 10,000 cfm discharged at the base of the reactor, directed to rise through the annular area between the reactor wall and the reactor insulation. Of the 11,400 cfm of cooling air introduced below the reactor, 10,000 cfm travels up through the annular passage between the reactor insulation and the cavity wall preventing stratification and accompanying high temperatures. This air exits partly through the annulus around the reactor nozzles and partly around the top reactor edge. Fifty cfm of air is directed through ducts to each of the eight neutron detector wells. This air also exits through the annulus and around the reactor edge. Also, 3,500 cfm of air is directed through each of the reactor supports exiting as explained above. The air is supplied to the reactor cavity at three locations: below the reactor at elevation (-)40'-4"; at the neutron detector area at elevation (-)33'-4"; and directly through each of the four reactor vessel supports.

b. Containment Structure Recirculating Filter System

The compliance of the Primary Containment Recirculating Air Filtration System to the requirements of Regulatory Guide 1.140, Rev. 1, October 1979, is outlined in Table 9.4-22.

The Recirculating Filter System (Figure 9.4-13) consists of a filter unit, two redundant van axial fans, each with redundant automatically controlled filter/recirculation duct dampers and ductwork. Each redundant fan and damper is powered from a redundant 460-volt motor control center. The recirculating filter system equipment is located within the containment at elevation 25'-0". The ductwork extends from this elevation to the top of containment.

The filter unit consists of a prefilter, upstream HEPA filter, and a carbon adsorber bed installed within a sheet metal housing. When the filter mode is selected at the main control board, the filter dampers will open and the recirculation duct dampers will close for the single selected fan. The filter damper and recirculation duct damper of the inoperative fan will remain in the normal, non-running condition, i.e., open to recirculation; closed to the filter.

Containment air enters the filter unit, passes through the operating fan and is discharged through ductwork located below elevation 25'-0". Should the operator stop the fan, the damper will return to its original position.

In the recirculation mode, which is initiated by a "P" signal or operator action, the filter and recirculation damper of the operating fan remain in their normal position and air is recirculated. The standby fan's filter and recirculation dampers remain in the normal condition. Each fan/damper system is electrically independent so that a single failure will not impose operational limitations.

The filter unit dampers, ductwork and fans are designed to ANSI N509; however, the filter unit has no safety classification. The dampers, ductwork and fans are seismic Category I, Safety Class 3. The fan motors and electrical accessories for the dampers are Class 1E.

c. Containment Structure Online Purge Subsystem

1. Online Purge Supply Air Equipment

The containment online purge subsystem supply air fan (see Figure 9.4-14) draws filtered, preheated air for the Primary Auxiliary Building mechanical room at elevation 53'-0" and distributes it through an eight-inch supply air duct into the containment (Figure 9.4-14). Two inline butterfly valves are installed in the supply air line; one in the containment enclosure area and the other inside containment. Each valve is pneumatically activated, and is controlled by a separate redundant source so that a single failure will not prevent the closure of a given valve. The isolation valves are Safety Class 2, seismic Category I, and are fully described in Subsection 6.2.4.

The design information for the supply air fan is given in Table 9.4-8.

2. Online Purge Exhaust Air Equipment

The online purge subsystem exhaust equipment collects air from the containment and exhausts it to the normal exhaust filter unit located at elevation 81'-0" in the Primary Auxiliary Building. This filtered air is then discharged to the plant vent.

The purge exhaust line contains two butterfly-type control valves located in the filter room at the 81'-0" elevation of the Primary Auxiliary Building. These valves are installed in parallel within the system and are controlled separately from the main control board. Whenever the containment air pressure exceeds 0.65 psig, or falls below 0.35 psig, as indicated at the MCB, the operator will manually adjust the pressure back to the 0.5 psig value. This operation is performed by first positioning the coarse 8" control valve, COP-V-7, then making a fine adjustment to the 4" control valve, COP-V-8, until the pressure is within the set limits. Actual containment pressure is indicated at the MCB. The purge exhaust valves are NNS, and are in accordance with ANSI B16.5.

Two inline, isolation valves are installed in the exhaust air line (see Figure 9.4-14). One valve is installed on each side of the containment. These valves are described in Subsection 6.2.4 and are Safety Class 2, seismic Category I.

3. Leak Rate Test Exhaust Air Equipment

In addition to the purge exhaust function, the containment online purge exhaust line is also used as a venting path during containment leak rate testing. When venting, an 8" manually controlled butterfly valve located between COP-V-7 and the PAB normal exhaust filter unit is closed and an 8" manually controlled, butterfly valve is opened. The venting rate is controlled by modulating valve COP-V-8 from the MCB. The valves are NNS and are in accordance with ANSI B16.5.

d. <u>Containment Structure Air Purge and Heating Subsystem</u>

The containment air purge and heating subsystem employs two sets of supply and exhaust equipment with common ductwork. Each set consists of a supply air fan and exhaust air fan, each with pneumatically operated dampers. The exhaust fans and dampers are located in the PAB mechanical equipment room at elevation 53'-0" (see Figure 9.4-5, Figure 9.4-6, Figure 9.4-7, Figure 9.4-8, Figure 9.4-9 and Figure 9.4-10). A common ductwork system, which includes the refueling purge supply and heating subsystem and the pre-entry purge subsystem, is routed through the PAB and containment enclosure into the containment at elevation 19'-3". The supply and exhaust ductwork are isolated on the outboard side of each containment penetration during plant Modes 1, 2, 3, and 4 by a blind flange using a resilient double o-ring seal design. Each penetration is isolable during Modes 5 and 6 by an in-board and/or outboard pneumatically activated butterfly valve (Figure 9.4-14). The penetrations are further discussed in Subsections 3.8.2.1 and 6.2.4.2.

1. Pre-Entry Purge Subsystem

   During pre-entry purge, a single fan supplies pre-entry purge air to the containment area using common supply ductwork. A single exhaust fan pulls air from containment through common exhaust ductwork and discharges directly to the unit plant vent after first passing through the filter unit located in the CEVA 21' —6" El. and the containment air purge air cleaning unit. The compliance of the containment pre-entry purge exhaust (filtered) cleaning unit to the requirements of Regulatory Guide 1.140, Rev. 1, October 1979, is outlined in Table 9.4-23.

   The RCA tunnel exhaust subsystem described under Subsection 9.4.12 is connected into the exhaust ductwork on the inlet side of the air cleaning unit. During Modes 1, 2, 3 and 4, the pre-entry purge subsystem is used to exhaust from the RCA Tunnel only. The air quantity through the fan and air cleaning unit remains constant at 15,000 cfm. The air quantity exhausted through the plant vent is 4,000 cfm from the RCA Tunnel. The excess air (11,000 cfm) generated by the exhaust fan is recirculated through the air cleaning unit. During refuelings when used for pre-entry purge, the full 15,000 cfm is exhausted through the plant vent. These flows are adjusted by manual operation of balancing dampers.

2. Refueling Purge Subsystem

   A single fan supplies refueling purge and heating (when required) air to the containment area during the refueling operation using, as described above, the same ductwork as the pre-entry purge system. Dampers are used to isolate the nonoperating system, in this case, the pre-entry purge. The 40,000 cfm exhaust air flow of the refueling purge subsystem first passes through a filter unit located in the CEVA 21' -6" El. before discharging to the plant vent.

   During refueling purge subsystem operation, RCA tunnel exhaust is maintained by operating the pre-entry purge subsystem in the same configuration as during Modes 1, 2, 3 and 4. Isolation dampers prevent recirculating air through the ductwork of the refueling purge exhaust subsystem.

e. Control Rod Drive Mechanism Cooling Subsystem

A metal shroud surrounds the CRDMs for their full height to direct cooling air along the length of the CRDMs. Air is drawn in through four nozzles spaced around the CRDMs at the reactor vessel head interface, and up past the CRDMs. The air then exits the metal shroud at the top (see Figure 9.1-12).

Three cooling fans are provided. Two out of the three fans normally operate with the third fan in standby. Operation of any two fans will produce a cooling air flow rate equal to or greater than the design cooling air flow rate of 46,000 scfm, and average velocities across the CRDM coil stacks of 30-50 fps.

Operation of more or fewer than two fans is alarmed. Temperature sensors located in the air outlet flow path alarm low or high CRDM cooling air exit temperature. Higher than normal air temperature would indicate fewer than two fans operating, whereas low air temperature would indicate a failed open outlet backdraft damper or three fans in operation.

Even if all cooling capability were lost, the reactor could be tripped and safely shut down. The cooling function does not influence the safety of the CRDMs in their ability to trip the reactor when necessary.

The fans are controlled from the MCB with one fan powered from Train A and two from Train B. The fans and dampers are further described in Table 9.4-8.

In the event of a "P" signal, the fans will stop. These fans cannot be restarted by resetting the signals. Should a loss of offsite power occur, the previously operating fans will restart in accordance with the emergency power sequencer.

The CRDM cooling fans have no safety-related function and are non-seismic Category I.

f. RCA Tunnel Exhaust System

An exhaust register located approximately at elevation 36'-0" in the RCA walkway exhausts the air supplied to the RCA tunnel. A ductwork system is routed from the register to the containment air purge cleaning unit located at elevation 53'-0".

9.4.5.3 Safety Evaluation

Failure of the filter unit of the containment structure recirculating filter subsystem will not affect the safe operation or shutdown of the plant since the air cleaning unit has no safety design bases. The fans, ductwork and dampers associated with the Containment Recirculation System are redundant and, as such, a single active failure will not render the system inoperative. In addition to component redundancy, each fan is connected to a separate train of the Emergency Power System to assure the availability of power in the event of a loss of offsite power.

Both recirculation fans run automatically upon the receipt of a "P" signal and the control dampers will be automatically positioned to block air flow through the air cleaning unit while allowing flow through the recirculating ductwork.

The containment isolation valves and associated ductwork (pipe) of the containment online purge and containment air purge systems are ANSI Safety Class 2 seismic Category I, and are fully described in Subsection 6.2.4.

In the event of a loss of primary component cooling water flow the containment structure cooling units will stop. These units have no safety design bases.

All other components, active and passive, of the containment air purge and heating system, containment online purge system and containment structure cooling system have no safety design bases.

Air flow patterns are maintained in each nonsafety system by the use of isolation, backdraft, and/or volume control dampers.

Nonseismic Category I components of systems in the vicinity of safety-related systems or equipment are located or supported in such a way that if failure should occur as a result of a seismic event no damage will occur to the safety-related equipment.

9.4.5.4 Inspection and Testing Requirements

During preoperational testing, the various containment ventilation systems are balanced and adjusted to design air flows. System operability, control and alarm functions are verified.

Initial and periodic testing of the containment recirculation filter unit is conducted in accordance with Regulatory Guide 1.140.

9.4.6 Containment Enclosure and Adjoining Areas Cooling and Ventilation System

The containment enclosure and adjoining areas cooling and ventilation systems are comprised of a normal cooling and ventilation system and an emergency cleanup system. The normal cooling and ventilation systems are described below. The emergency cleanup exhaust system is further discussed in Subsection 6.5.1, Engineered Safety Features filter systems.

9.4.6.1 Design Bases

The containment enclosure and adjoining areas cooling systems are designed to remove equipment heat from the following areas during normal and emergency operation:

- Charging pump areas
- Safety injection pump areas
- Residual heat removal equipment areas
- Containment spray pump and heat exchanger equipment areas
- Mechanical penetration area
- Containment enclosure ventilation equipment area
- H_2 analyzer room and electrical room areas
- RHR vault stairway area
- Electrical tunnel personnel walkway (electrical) area.

a. Containment Enclosure Cooling Systems

The containment enclosure cooling units maintain the first six areas above at or below the safety-related equipment's maximum design operating temperatures during normal operation and following a LOCA, loss of offsite power, high and moderate pipe breaks, SSE and tornados, as outlined in the Service Environment Chart, Figure 3.11-1.

Redundant containment enclosure cooling units are provided, each with an independent supply of primary component cooling water and emergency power, so that a single active failure will not cause a loss of cooling capacity.

For normal operation, the containment enclosure cooling and ventilation system will maintain the areas served at or below 104°F for an outside temperature of 88°F or lower. Under emergency plant operation, the cooling units will limit the temperatures in the equipment areas to maximum design conditions, based on the transient peak temperature of the Primary Component Cooling Water (PCCW) System which serves as the cooling medium for the cooling units.

The containment enclosure area ventilation system functions so that the ventilation air is controlled to flow from areas of low potential radioactivity toward areas of higher potential radioactivity, and then exhausts to the unit plant vent for atmospheric dispersion. Radioactivity releases are maintained within the limits of the Technical Specifications by the emergency exhaust cleanup system discussed in Subsection 6.5.1.

b. H_2 Analyzer/Electrical Rooms Ventilation System

The H_2 analyzer and electrical room supply fans maintain area 7 at or below the safety-related equipment's maximum design operating temperatures during normal operation and following a LOCA, loss of offsite power, high and moderate pipe breaks, SSE, as outlined in the Service Environment Chart, Figure 3.11-1.

A redundant supply fan is provided with an emergency power source so that an active failure of one fan will not cause a loss of cooling capacity in the H_2 analyzer and electric room areas.

For normal operation, the H_2 analyzer electrical room ventilation system will maintain the areas served at or below 104°F for an outside temperature of 88°F or lower.

c. RHR Vault Stairway Cooling System

The RHR vault stairway chilled water cooling units maintain area 8 at or below safety-related equipment's maximum design operating temperature during normal operation, as outlined in the Service Environment Chart, Figure 3.11-1. This temperature is 104°F coincident with an outside temperature of 88°F. The system provides auxiliary cooling to maintain area temperatures below 104ºF. The cooling system is non-safety related and is operated as required to maintain the desired area temperature.

d. Electrical Tunnel Personnel Walkway Cooling System

The electrical tunnel personnel walkway chilled water cooling units maintain area 9 at or below safety-related equipment's maximum design operating temperature during normal operation, as outlined in the Service Environment Chart, Figure 3.11-1. This temperature is 104°F coincident with an outside temperature of 88°F. The system provides auxiliary cooling to maintain area temperatures below 104ºF. The cooling system is non-safety related and is operated as required to maintain the desired area temperature.

The containment enclosure cooling system and return fans and H_2 analyzer and electrical room fans are designed to remain functional and will support continuous operation of safety class equipment during and after an SSE while assuming a loss of offsite power and a single active failure.

The containment enclosure cooling units, return fans, return dampers and ductwork and H_2 analyzer and electrical room ventilation system fans, dampers and ductwork are classified as Safety Class 3 and seismic Category I.

See Table 9.4-1 for industry standards and codes for HVAC system components; see Table 9.4-9 for containment enclosure area HVAC system performance parameters.

9.4.6.2 System Description

a. Containment Enclosure Cooling System

The Containment Enclosure Cooling System is located on elevation 21'-0" of the containment enclosure ventilation area (see Figure 9.4-5, Figure 9.4-6, Figure 9.4-7, Figure 9.4-8, Figure 9.4-9 and Figure 9.4-10 for the containment enclosure ventilation system flow diagram). The system consists of redundant fans, filters, cooling coils and dampers.

The recirculation air from the safety-related equipment areas is filtered prior to cooling using filters with a 75 percent minimum average resistance based on ASHRAE Standard 52-68 for synthetic dust.

During normal operation, makeup air is provided to the containment enclosure ventilation area from the PAB supply fans. The containment enclosure cooling units draw air from this area and filter, cool, and distribute it via ductwork to the first six above listed areas. Redundant return air fans draw air from all these areas except the charging pump rooms for return to the containment enclosure ventilation area via ductwork. The charging pump rooms are exhausted through the PAB cleanup exhaust system to the atmosphere via the unit plant vent.

Following a LOCA (upon receipt of a "T" signal), upon loss of makeup air from the PAB supply fans, or upon loss of exhaust air to the PAB cleanup exhaust system, both the supply duct from the PAB to the containment enclosure ventilation area and the exhaust duct from the charging pump rooms to the PAB are isolated. Redundant isolation dampers are installed in series in each of these ducts. One damper per duct is located in the PAB and one in the containment enclosure. Upon receipt of a "T" signal, both redundant dampers in the supply and exhaust ducts will close. Only the supply and exhaust isolation dampers located in the PAB will close on loss of makeup or exhaust air. For each of these scenarios, the Train B return air fan is actuated automatically to draw air from the charging pump rooms to the CEVA. In the event the Train B fan fails to start, the fully redundant standby fan (Train A) will be actuated after a preset time delay.

Following a LOCA, the areas listed at the beginning of Subsection 9.4.6.1, the electrical penetration area, and the containment annulus will be isolated, and maintained at a negative pressure with respect to the outside by the containment enclosure exhaust filter system, as described in Subsection 6.5.1.

During normal operations, 23,400 cubic feet per minute of filtered outside air is provided to the containment enclosure ventilation area from the PAB ventilation system, and an equivalent amount of exhaust air is withdrawn from the charging pump areas. In winter, the makeup air is heated to offset the building heat losses of the areas served.

The makeup air system and exhaust system are described in Subsection 9.4.3, Primary Auxiliary Building Heating and Ventilating System. These systems are automatically isolated from the containment enclosure ventilation system by redundant isolation dampers upon receipt of a "T" signal.

High temperature of each safety-related equipment room is alarmed in the control room. Instrumentation is provided on each filter unit to monitor and alarm abnormal conditions of differential pressure and temperature.

Differential pressure between the containment enclosure area and the outside environment, as well as that between the Primary Auxiliary Building and the containment enclosure area, will be maintained by the emergency exhaust air cleaning units. Low differential pressure is alarmed in the control room.

b. H_2 Analyzer/Electrical Rooms Ventilation System

The supply fans are located in the H_2 analyzer room (see Figure 9.4-15).

The hydrogen analyzer room and the electrical room are each ventilated and cooled with filtered outside air supplied through one of two redundant supply fans and exhausted to the outdoors through gravity-operated relief dampers. Each fan is controlled by a separate room thermostat. Setpoints are staggered to avoid simultaneous operation of the redundant fan. Fan operation is indicated on the central computer.

The heating system consists of electric unit heaters each individually controlled by its own room thermostat.

c. RHR Vault Stairway Cooling System

Each of the north and south stairwells is provided with two redundant nonsafety-related cooling units.

The cooling units are located at elevation 20'-8" (see Figure 9.4-5, Figure 9.4-6, Figure 9.4-7, Figure 9.4-8, Figure 9.4-9 and Figure 9.4-10). Each chilled water cooling unit has filters, cooling coils, damper and ductwork. The cooling units and associated ductwork installed within the area are seismically supported.

The conditioned air to each stairwell is distributed through sheet metal duct systems and supply registers and returned directly to the unit.

The chilled water cooling units are connected to one of two redundant chiller units by a glycol-chilled water piping system complete with one circulating pump in each chiller circuit. The same chiller units, piping system and pumps also serve the electrical tunnel personnel walkway described under Subsection 9.4.6.2d.

The RHR vault stairway is not provided with air from any other ventilation system, and all air within the stairway will be recirculated.

Each cooling unit fan is controlled by a separate room thermostat. Setpoints are staggered to avoid simultaneous operation of the redundant cooling unit. The glycol water pumps are each individually and manually controlled by a local control switch. Each chiller unit is individually and manually controlled by a local control switch. The chillers are interlocked with the flow switches installed in the piping system and, hence, pumps should be manually started before the chillers can start. Each chiller unit is also provided with internal head pressure controls and motor overloads. The refrigerant used in the liquid chiller units is Refrigerant 22 (chlorodifluoromethane). Each compressor control system is provided with a low ambient compressor cutout to prevent operation below 0°F ambient outdoor temperature. A flow switch is provided in the chilled water circuit to indicate water flow which will allow the chiller to operate.

d. Electrical Tunnel Personnel Walkway Cooling System

The redundant nonsafety-related chilled water cooling units are located within the elevation 20'-8" area (see Figure 9.4-5, Figure 9.4-6, Figure 9.4-7, Figure 9.4-8, Figure 9.4-9 and Figure 9.4-10). Each chilled water cooling unit has filters, cooling coils, dampers and ductwork. The cooling units and associated ductwork installed within the area are seismically supported.

The air is distributed at the elevation 30'-3" level, and returns through a floor opening to the cooling unit by normal air circulation.

The chilled water cooling units are connected to one of two redundant chiller units by a glycol-chilled water piping system complete with one circulating pump in each chiller circuit, as described for RHR vault stairway cooling system circuit, Subsection 9.4.6.2.

The personnel walkway is not provided with air from any other ventilation and all air within the area will be recirculated.

The cooling units are controlled as described in Subsection 9.4.6.2.

9.4.6.3 Safety Evaluation

a. Containment Enclosure Cooling System

The containment enclosure cooling units are redundant so a single active failure will not render the system inoperative. Since each cooling unit is connected to a separate train of the Emergency Power System, availability of power in the event of loss of offsite power is ensured. Each is supplied cooling water from a separate loop of the PCCW system, described in Subsection 9.2.2.

Both pairs of return fans (one pair servicing the equipment vaults and one pair servicing the charging pump rooms) are also redundant so a single active failure will not render either system inoperative. Since the fans of each pair are connected to separate trains of the Emergency Power System, availability of power in the event of loss of offsite power is ensured.

The emergency exhaust duct penetration through the roof is protected by a tornado damper as described in Section 3.3.

The makeup air and normal exhaust systems, except for the isolation and return dampers, are not required to operate following a LOCA.

The containment enclosure cooling units, return fans, ductwork and ductwork supports, isolation and return dampers, and emergency exhaust air cleaning units are designed to operate under a SSE and are protected from tornado-borne missile damage.

Nonseismic Category I components of systems in the vicinity of safety-related systems are located or supported so that if failure due to a seismic event should occur, there will be no damage to safety-related components, equipment or systems.

b. H_2 Analyzer/Electrical Rooms Ventilation System

The supply fans are redundant so a single active failure will not render the system inoperative. Since each fan is connected to a separate train of the Emergency Power System availability of power in the event of a loss of offsite power is ensured.

The fans, dampers and ductwork are safety-related and capable of maintaining the design temperature in the areas after a simple active failure.

The unit heaters are not safety-related and, therefore, have not been evaluated.

There are no high or moderate energy line breaks which could, upon their failure, affect the performance of the safety-related equipment.

c. RHR Vault Stairway Cooling System

The system is not a safety-related system, and is not required to operate during a LOCA or loss of offsite power.

All components of the system are located or supported so that if failure due to a seismic event should occur, no damage will result to safety-related components, equipment or systems.

Redundant nonsafety-related cooling units provided in each north and south stairways ensure availability of at least one cooling unit in the event of a mechanical malfunction in the second cooling unit. Availability of the cooling units is further enhanced by providing redundant chillers and chilled water/glycol piping systems.

d. Electrical Tunnel Personnel Walkway Cooling System

The system is not a safety-related system, and is not required to operate during a LOCA or loss of offsite power.

All components of the system are located or supported so that if failure due to a seismic event should occur, no damage will result to safety-related components, equipment or systems.

Redundant nonsafety-related cooling units provided in this area ensure availability of at least one cooling unit in the event of a mechanical malfunction in the second cooling unit. Availability of the cooling units is further enhanced by providing redundant chillers and chilled water/glycol piping systems.

9.4.6.4 Inspection and Testing Requirements

During preoperational testing, all systems listed under Subsection 9.4.6.1 are balanced and adjusted to design air and water flows, and system operability, control and alarm functions are verified.

9.4.7 Electrical Penetration Area Air Conditioning System

The air conditioning system function is to remove heat created by equipment and lighting in the electrical penetration areas.

9.4.7.1 Design Bases

a. Train A and Train B electrical penetration areas are air conditioned by separate and redundant air conditioning systems.

b. The air conditioning systems are designed to maintain temperatures as outlined in Figure 3.11-1 for zones ET-3A and ET-3B. Heating is not provided since the minimum operating temperature of the area is above design requirements. This low limit will not be reached even during a winter plant shutdown.

c. The electrical penetration area air conditioning equipment is ANSI Safety Class NNS (Nonnuclear Safety) and has no seismic requirements.

d. The electrical penetration area air conditioning systems are not designed to remain functional during and after a LOCA, and SSE, or during a loss of offsite power.

e. The air conditioning equipment is redundant, and is capable of maintaining the design temperature in the area after a single active failure.

f. The duct and piping supports are seismically qualified to prevent the ductwork or piping from falling and endangering safety-related equipment.

g. The codes and standards applicable to this equipment are listed in Table 9.4-1.

9.4.7.2 System Description

The electrical penetration area air conditioning systems air flow and piping diagram is shown on Figure 9.4-15; the equipment parameters are summarized in Table 9.4-10.

Each of the electrical penetration areas is supplied with conditioned air through sheet metal duct systems which are seismic Category I supported. The air is distributed through diffusers to maintain the design room temperature, and is returned directly to the fan coil units through a grille in each unit. No makeup or outside air is introduced into the electrical penetration area.

Because of the physical separation of electrical Trains A and B, two 100 percent capacity air conditioning systems are provided. Train A, at Elevation 0'-0", has two independent direct expansion fan coil air conditioning units, each with associated backdraft damper, ductwork and air-cooled refrigerant condensing unit located on grade immediately north of the electrical penetration area. Train B, at elevation (-)26'-0", has equipment similar to Train A.

The evaporator fan in the fan-coil unit runs continuously once the control switch on the control panel (CP-23) located in the main control room is placed in the automatic position. Cooling is provided by cycling the compressor/condenser unit to satisfy a local thermostat. Should a single active failure occur, another locally mounted thermostat will initiate an alarm in the main control room. The operator then starts the standby air conditioning system manually by setting the control switch on the control panel (CP-23) in the "start" position. The malfunctioned unit is manually stopped for inspection and repair by setting control switch in the ‘off’ position.

Each of the fan-coil units is connected to a compressor/condenser unit by refrigerant tubing.

In addition to a refrigerant high pressure switch, each compressor has internal motor overloads which shut down the compressor if the motor windings overheat. An internal pressure relief valve prevents the compressor from developing pressure great enough to cause refrigerant barrier failure.

Since only one evaporator fan normally operates, backdraft dampers are provided in the discharge airstream of each of the two fan-coil units. When one fan is operating, reverse circulation of air through the second fan coil unit is prevented by the backdraft damper in the second fan-coil unit.

Should a loss of power occur, the electrical penetration area air conditioning system will not remain operational, and during a LOCA, the temperature in the electrical penetration area (either/or both Train A and Train B) would rise to the steady-state temperatures indicated in Figure 3.11-1, the maximum design temperature for the area.

Each electrical penetration area air conditioning system is operated from its corresponding electrical bus.

The fan-coil units are housed in seismic Category I structures designed to withstand the effects of flooding, wind and tornado loading, and tornado missiles. Internal and external missiles are discussed in Section 3.5. Protection against the dynamic effects associated with the postulated rupture of pipe is discussed in Section 3.6.

9.4.7.3 Safety Evaluation

The air conditioning equipment, fan-coil units, backdraft dampers and compressor/condenser units have no safety design bases. The ductwork is seismic Category I supported and, in the event of an SSE, will not fail in a manner to damage nearby safety-related equipment or cable.

There are no high or moderate energy lines which, upon failure, could affect the performance of the electrical penetration area air conditioning systems.

9.4.7.4 Inspection and Testing Requirements

During preoperational testing, the electrical penetration area air conditioning systems are balanced and adjusted, and design air flow and system operability, automatic control, and alarm functions are verified.

9.4.8 Diesel Generator Building Heating and Ventilating System

The Diesel Generator Building (DGB) heating and ventilating system functions to remove heat generated in the building during normal and emergency conditions and also maintains the design winter indoor building temperature, as described below.

9.4.8.1 Design Bases

The DGB ventilating system is a once-through system designed to remove the heat rejected by the diesel generators and building lighting during normal operation. The ventilating system is also designed to maintain the indoor design conditions given below during the most severe emergency operation of the diesel generators at their continuous rating. The ventilation system is also capable of exhausting sufficient air from the diesel generator area to prevent any accumulation of inflammable fuel-vapor mixture.

The outdoor ambient conditions used for the design of this system are: winter dry bulb temperature 0°F; summer dry bulb temperature 88°F. The indoor ambient design conditions are given in Figure 3.11-1.

The DGB heating and ventilating system is housed in seismic Category I structures designed to withstand the effects of flooding and tornado missiles. Wind and tornado loadings are discussed in Section 3.3; flood design in Section 3.4; and internal and external missiles in Section 3.5. Protection against dynamic effects associated with the postulated rupture of piping is discussed in Section 3.6. Environmental design of mechanical and electrical equipment is discussed in Section 3.11.

The fans and dampers are ANS Safety Class 3 and seismic Category I. All other equipment is nonsafety class and nonseismic Category I. The hot water heating piping, unit heater and ductwork supports are designed as seismic Category I, so that they will not fail in a manner to damage safety-related equipment in the event of an SSE. Failure of the roll filters during an SSE will not prevent the remaining ventilating components, fans and dampers from performing their function.

The codes and standards for the system components are presented in Table 9.4-1.

9.4.8.2 System Description

The DGB ventilation and heating system is shown in Figure 9.4-16 and Figure 9.4-18 respectively and includes the following subsystems:

- Ventilation System

- Heating System

Equipment performance data is listed in Table 9.4-11.

a. DGB Ventilation System

A separate ventilation system, consisting of one supply air and one exhaust air fan, an automatic roll filter, and associated dampers, is provided for each of the redundant diesel generators, Train A and Train B. Each supply fan is equipped with a mechanical backdraft damper to prevent backward fan rotation due to reverse air flow. Each of the supply and exhaust fans, as well as the roll filter drive, is powered from its respective train to provide 100 percent redundancy. All of the fans and roll filters are located at elevation 51'-6" of the DGB.

The ventilation system for each diesel generator area is automatically controlled from its local motor control center (MCC) by placing the respective control switch in the auto position. The exhaust damper, exhaust fan and supply fan are operated and controlled by locally mounted thermostats as follows:

1. When the thermostat first calls for ventilation, the exhaust damper opens to provide natural ventilation by gravity.

2. If the temperature continues to rise, the supply fan and the exhaust fan will start to provide the full ventilation air flow.

As the temperature drops in the diesel generator area, a reverse sequence of fan and damper operation will occur under control of the thermostats. When the diesel generator is running, temperature controls are bypassed. The operator may elect to run the ventilation system manually from the MCC. In this case, the system will operate as before, except the thermostats will not control damper or fan operation. Diesel generator area high temperature is alarmed. The roll filters, one per diesel generator train, operate in the auto/manual mode when advancing the roll filter media. In the auto-mode of operation, the roll filters advance on a high differential pressure signal to provide clean filter media. The roll filters advance may also be controlled manually from the local panel.

b. DGB Heating System

The DGB heating system provides heat to each diesel generator area, and is shown on Figure 9.4-18.

Heating for the DGB is provided by hot water unit heaters. Four unit heaters are located in each diesel generator area at elevation 21'-6". Each of the two area heating systems is provided with hot water from the hot water/steam converter, as described in Subsection 9.4.10.

Three hot water circulating pumps, one for each area and the third, a standby for both, are energized from the local control panel and will run until the operator manually stops them. Should one of the hot water circulating pumps fail, system performance will not be affected after the spare pump is manually placed in operation.

Operation of the unit heaters is thermostatically controlled after placing an individual locally mounted control switch in the auto position. The unit heater fans are cycled on and off by the thermostats. Each thermostat, two per area, controls two unit heater fans.

Electric unit heaters are provided in the day tank rooms of the DGB, so the temperatures in the rooms do not fall below minimum design temperature. The explosion-proof unit heaters are controlled by room thermostats. A low temperature switch in each room will alarm (on the computer panel located in the control room) if the room temperature falls to a predetermined setpoint.

9.4.8.3 Safety Evaluation

Failure of one of the hot water unit heaters will not significantly affect the system performance since the heating system has been designed to include a 10 percent safety factor.

The ventilation systems are redundant; therefore, a single active failure of one ventilation system will not prevent the other ventilation system from operating.

Loss of offsite power will not effect the ventilation systems, since the exhaust dampers fail open and each set of Diesel Generator Building supply and exhaust fans is connected to separate trains of the Emergency Electrical Power System.

Failure of one of the ventilation fans to start when they are required is alarmed in the control room.

Normal operation of the ventilation system would not be affected should a hot water line rupture. Since the total amount of water in the Hot Water Heating System versus the building volume is negligible, the safety-related equipment will not be affected.

The increase in temperature due to the water flashing to steam will cause the supply and exhaust fans to operate, if they are not already in operation. The hot water heating piping is contained or shielded where they pass over safety-related electrical equipment. The exhaust fans and outside air intakes are protected from wind-borne missiles by concrete shields.

9.4.8.4 Inspection and Testing Requirements

During the preoperational test program, the Diesel Generator Building heating and ventilation system is balanced and adjusted to design air flow. System operability, controls and alarm functions are verified. Periodic operability tests of the supply and exhaust fans and associated dampers are performed during periods when the diesel generator is required to be operable.

9.4.9 Cable Spreading Room Ventilation System

9.4.9.1 Design Bases

The function of the heating and ventilation system for the cable spreading area, located on elevation 50'-0" of the Control Building, is to control inside design temperatures by using filtered outside air and/or recirculated air.

Operation of the cable spreading room ventilation system serves no safety-related function. The system is not required to remain functional following a LOCA, safe shutdown earthquake or tornado. The power supply cubicle and the control switch for the supply fan are safety-related, class 1E, to prevent the fan from starting inadvertently, thereby ensuring that the cable spreading room is not over-pressurized.

Although normally in standby status, to preclude an undetected equipment failure from causing a cable spreading room overpressurization, the cable spreading room ventilation system is designed to maintain the minimum and maximum design temperatures listed in Figure 3.11-1 when in operation.

See Table 9.4-1 for codes and standards for HVAC system components.

9.4.9.2 System Description

This standby ventilation system consists of a single supply fan, a single return fan, and supply air and return air duct work. The system is only placed into service using administrative controls. See Figure 9.4-19 for the ventilation flow diagram. When the system is in operation, the cable spreading room is ventilated in the summer with filtered outside air. In the winter, the cable spreading room ventilation system air is recirculated and is mixed with preheated outside air, as necessary, for makeup and to maintain the inside design temperature. In addition, the supply air is reheated, when required, by a hot water heating coil in the supply ductwork to offset building heat losses. The cable spreading room ventilating system obtains makeup air and hot water for heating from the 4-kV switchgear area and battery rooms heating and ventilating system described in Subsection 9.4.10.

Supply air temperature is controlled automatically by positioning the recirculation, exhaust and outside air dampers through a temperature controller located in the 4-kV switchgear area. Abnormal temperature conditions in the cable spreading area are alarmed in the control room.

Delivery of air from the supply air fan to the cable spreading area will stop if smoke is detected in the area. The return air fan continues to vent, if operating.

9.4.9.3 Safety Evaluation

Operation of the cable spreading area heating and ventilation system serves no safety-related function. In the event the system fails to operate, it will have no effect on the safe operation or safe shutdown of the plant. The power supply cubicle and the control switch for the supply fan are safety-related, class 1E, to prevent the fan from starting inadvertently, thereby ensuring that the cable spreading room is not over-pressurized. The ductwork is seismically supported to prevent its failing in the event of an SSE.

9.4.9.4 Inspection and Testing Requirements

During the preoperational test program, the cable spreading room ventilation system is balanced and adjusted to design air flow. System operability, controls and alarm functions are verified.

9.4.10 4-kV Switchgear Area, Battery Rooms and Electrical Tunnels Heating and Ventilation Systems

The function of these heating and ventilation systems is (a) to control design temperatures in the 4-kV switchgear area, (b) to prevent the buildup of generated hydrogen gas and to control inside design temperatures in the battery rooms and (c) to control inside design temperatures in the electrical tunnels.

9.4.10.1 Design Bases

The 4-kV switchgear area and battery room ventilation system during both normal and emergency plant operation are capable of maintaining the switchgear areas and electrical tunnel area temperatures as listed in Figure 3.11-1 when the outside air temperature is 88°F or lower during the summer and when the outside air temperature is 0°F during the winter.

The redundant 4-kV switchgear area and the battery room ventilation system will support continuous equipment safety and operation during and after an SSE, while assuming a loss of offsite power and a single active failure.

The electrical tunnel areas return system during normal operation, in conjunction with the 4-kV switchgear area and battery room ventilation system, maintains the electrical tunnel temperatures stated above.

The systems are protected against the effects of natural phenomena, such as earthquakes, hurricanes and floods. The systems are protected against the effects of tornado-generated missiles and internally generated missiles, pipe whip and jet impingement resulting from pipe breaks.

The 4-kV switchgear ventilation system is designed so that it can be balanced to maintain a slight positive pressure within the switchgear area to minimize the infiltration of dust and dirt.

The switchgear area and battery rooms supply, return and exhaust fans, ductwork and duct system supports are designed to operate under an SSE and are protected from tornado-borne missile damage and tornado-induced pressures. The emergency switchgear areas and each of the battery rooms are provided with ionization fire detection devices which are alarmed in the control room.

The hot water heating system for the switchgear area is designed to maintain the temperatures given above. Hot water for circulation is generated in a steam/hot water converter which uses auxiliary steam to heat the water. Hot water/glycol is used as the heating medium.

The nonseismic components or duct systems located in areas containing safety-related equipment are located so that their failure due to a seismic event will not result in damage to nearby safety-related equipment, components or systems.

The 4-kV switchgear area and battery rooms ventilating systems are classified ANSI Safety Class 3, seismic Category I.

The systems are designed to meet the intent of 10 CFR Part 50, Appendix A, General Design Criteria (GDC) 2, 4, and 5 and Regulatory Guides 1.26 and 1.29.

See Table 9.4-1 for codes and standards for HVAC system components.

9.4.10.2 <u>System Description</u>

See Figure 9.4-20 for the ventilation air flow diagram and Table 9.4-12 for equipment parameters. The 4-kV switchgear areas, battery rooms and electrical tunnels are ventilated in the summer with filtered outside air, supplied from the Diesel Generator Building outside air intake. Each redundant switchgear train area has a supply fan, a return fan and supply and return ductwork. The battery rooms and electrical tunnels ventilation air is provided by the 4-kV switchgear area supply fans. The battery rooms have redundant exhaust fans, and redundant supply and exhaust ductwork. The electrical tunnels have a single return fan and return ductwork. The supply air and exhaust air systems for the battery rooms are balanced to maintain the battery rooms under a negative pressure of approximately 0.1 inch H_2O, thereby preventing any hydrogen generated by the batteries from infiltrating the emergency switchgear areas.

In the winter the 4-kV switchgear areas, cable spreading area (see Subsection 9.4.9) and the electrical tunnel area air is recirculated and mixed with preheated outside air, as necessary, for makeup and to maintain the inside design temperature. The 4-kV switchgear areas and battery rooms have two ventilation equipment rooms, one for each train. The equipment rooms serve as a return air/makeup air mixing plenum. The heat required to offset building heat loss from the switchgear areas, battery rooms and electrical tunnels is supplied by hot water unit heaters located in the equipment rooms. Water line breaks or hot water system failures will not affect the operation of the switchgear areas or battery rooms.

The minimum design temperature for the switchgear areas is based on the requirement that the temperature in the battery rooms is maintained at 65°F or above for B-1A and B-1C and 60ºF or above for B-1B and B-1D. Electric reheat coils are provided in the supply air ductwork to the battery rooms. The electric reheat coils are energized when the battery room temperatures fall below 67°F.

Alarms are generated and indicated in the Main Control Room if either of the switchgear area supply fans fails to develop adequate discharge pressure, or if the battery rooms exhaust fans fail to develop adequate inlet pressure. Each system, except for the electrical tunnel return fan, is connected to a redundant emergency power supply and will receive power from the diesel generators should a loss of offsite power occur.

Seismic and safety classification of the components and systems is discussed in Section 3.2. Wind and tornado loadings are discussed in Section 3.3. Flood design is discussed in Section 3.4. Internal and external missile design is discussed in Section 3.5. Protection against dynamic effects associated with the postulated rupture of piping is discussed in Section 3.6. Environmental design of mechanical and electrical equipment is discussed in Section 3.11.

Temperatures in each battery room and 4-kV switchgear room are controlled through the temperature control system which automatically positions the associated recirculation, exhaust and outside air dampers. Off-normal conditions are alarmed in the control room.

9.4.10.3 Safety Evaluation

The power sources for the switchgear area supply and return fans as well as for the battery rooms redundant exhaust fans for both normal and emergency operation, are from redundant ESF buses. Since each system's power supply is electrically independent, no single failure will impose operational limits.

The supply and exhaust air openings in the Train A and Train B mechanical room walls serving the 4-kV switchgear areas and battery rooms are tornado protected as described in Section 3.3.

9.4.10.4 Inspection and Testing Requirements

During the preoperational test program, the 4-kV switchgear area, battery rooms and electrical tunnels heating and ventilating systems are balanced and adjusted to design air flow, and system operability, automatic control and alarm functions are verified.

Since the switchgear area, battery room and electrical tunnel ventilation equipment will normally be operating, no special periodic operational testing or in-service inspection are required. The heating system is inspected and checked each fall at the time when heating is first required.

9.4.11 Emergency Feedwater Pumphouse Heating and Ventilation System

The function of the heating and ventilating systems is to maintain the inside temperature of the emergency feedwater pumphouse within design limits for both normal and emergency feedwater system operation during summer and winter.

9.4.11.1 Design Bases

The emergency feedwater pumphouse ventilation system is designed to maintain the area temperature at or below 104°F during both normal and emergency feedwater system operation when the outside air temperature is 88°F or lower.

The two full-sized ventilation supply fans are seismic Category I and Safety Class 3, and the motors are Class 1E. Each fan is electrically powered from a separate ESF power source.

The ventilation system equipment is located in the Emergency Feedwater Pump-house, a seismic Category I structure, and is missile and flood protected and qualified to withstand the effects of tornadoes as described in Section 3.3.

The emergency feedwater pumphouse ventilation system is designed to meet the intent of 10 CFR 50, Appendix A, General Design Criteria (GDC) 2, 4 and 5 and Regulatory Guides 1.26 and 1.29.

The heating system is designed to maintain the pumphouse at or above 50°F when the outside temperature is 0°F or above. Two full-sized hot water unit heaters are provided, one as a spare. The heaters receive a mixture of water and glycol from pumps and a steam-to-water converter located in an adjacent area. A heating hot water line break or a failure of the heating system would not affect the operation of the emergency feedwater pumping equipment.

Codes and standards for the system components are presented in Table 9.4-1.

9.4.11.2 System Description

The emergency feedwater pumphouse ventilation system is shown on Figure 9.4-15. Heating and ventilating equipment and performance information are given in Table 9.4-13.

The pumphouse is ventilated and cooled with outside air supplied through one of the two redundant supply fans and its tornado gravity intake damper with pneumatic test operator, and exhausted through its tornado exhaust damper with pneumatic operator. Each fan and its exhaust damper is controlled by a separate room thermostat. Setpoints are staggered to avoid simultaneous operation of redundant equipment. Pumphouse high temperature is alarmed.

The heating system consists of a shared steam/hot water converter, two 100 percent capacity pumps, a piping system and two 100 percent capacity unit heaters. The heating medium is a mixture of water and glycol in a closed loop circulating system. The glycol acts to prevent freezing should the steam supply, electrical power source or a pump or driver fail. Each unit heater is controlled by its own room thermostat. Pumphouse low temperature is alarmed.

9.4.11.3 Safety Evaluation

The redundant, seismic Category I, Safety Class 3, pump room supply fans, supply and exhaust dampers and the Class 1E fan motors, each with electrical power from a separate ESF power source, assure continued ventilation should an SSE, loss of offsite power or a single failure occur. Loss of air or electrical power to the pneumatically operated supply and exhaust dampers will cause them to fail open.

Heating system operation is not required to assure proper operation of the pumping equipment or the electrical equipment in the Emergency Feedwater Pump-house. If an unlikely loss of the heating system occurs, the low temperature alarm will alert the operator of a potential freezing situation, and corrective action will be taken to prevent freezing.

9.4.11.4 Inspection and Testing Requirements

During the preoperational test program, the emergency feedwater pumphouse heating and ventilation system is balanced and adjusted to design air flow, and system operability, control and alarm functions are verified. Periodic operability tests of the supply fans and dampers are performed.

9.4.12 Administration and Service Building (RCA) Heating, Ventilation and Air Conditioning System

The operation of the Administration and Service Building heating, ventilating, and air conditioning subsystems for the radiation control area (RCA) is discussed in this section. Administration and Service Building subsystems include the air conditioning supply system, exhaust system, makeup air ventilating system, and heating system. Included are all equipment, ductwork, filters, controls, wiring and pneumatic control tubing necessary to provide complete, automatically operating systems. The systems also include all refrigerant piping, chilled water piping and hot water piping necessary for the air conditioning system and the heating system. The RCA HVAC system is shown in Figure 9.4-21.

9.4.12.1 Design Bases

The function of the Administration and Service Building RCA HVAC System is to provide outside air for summer and winter ventilation as well as to maintain temperatures within established design limits. The system is also designed to prevent infiltration of radioactivity-contaminated air from the RCA tunnel and exfiltration to the non-RCA portion of the Administration Building.

All components of the Administration and Service Building RCA HVAC subsystems are nonnuclear safety-related, with no seismic or safety requirements.

9.4.12.2 System Description

a. General Description

The Administration and Service Building HVAC Systems consist of the following:

1. Heating, ventilating, and air conditioning systems for the following areas:

   Count room

   Hot chemistry lab

   Corridors

   H.P. check point

   Passage

   RCA tunnel stairwell

2. Heating and ventilating systems for the following areas:

   Hot chemistry laboratory fume hoods

   RCA shop

   Women's locker and toilet

   RCA tunnel

The RCA is maintained at a slightly negative pressure relative to the areas outside of the RCA to minimize the possibility of exfiltration of RCA air to the atmosphere.

b. <u>Component Description</u>

1. Heating, Ventilating, and Air Conditioning System

The HVAC system consists of a central multi-zone air conditioning unit and a central single-zone air conditioning unit with a fan section, cooling coils, heating coils, electric duct humidifier, moderate efficiency filters and modulating dampers. The multi-zone unit uses chilled water for cooling. The single-zone system is a direct expansion type and includes a rooftop air-cooled condenser.

2. Heating and Ventilation System

The RCA tunnel HV system consists of a central single zone air handling unit with a fan section, electric heating coil and moderate efficiency filters.

All other HV systems consist of a central multi-zone air handling unit with a fan section, hot water heating coils, moderate efficiency filters, and modulating dampers.

3. Count Room Air Conditioning Systems

The Chemistry Count Room and HP Count Room Air Conditioning Systems consist of a recirculating air conditioning unit located inside the room. The system includes a fan, compressor, cooling coils, humidifier, dust filter, and an air-cooled condenser.

4. Continuous Exhaust System

The RCA tunnel is exhausted via CAP-F-40 located in the PAB.

The remaining HV systems consist of an exhaust system that is normally continuously operated and is comprised of exhaust fans, medium efficiency prefilters, absolute filters and radiation monitors.

5. Chilled Water System

The chilled water system components and accessories include two packaged automatic liquid chillers, two chilled water circulating pumps, two air cooled condensers, temperature and pressure gauges, hydronic air control specialties, strainers, stop, check and balancing valves.

6. Hot Water Heating System

The hot water heating system components and accessories include steam and water heat exchangers using externally supplied steam, primary hot water pumps, preheat coil pumps, unit heater circulating pumps, reheat coil pumps, unit heaters, temperature and pressure gauges, hydronic air control specialties, strainers, stop, check, mixing, and balancing valves.

7. Radiation Monitoring

Radiation monitors are provided in the exhaust ducts from the hot chemistry laboratory fume heads and in the common exhaust duct from all rooms/areas in the Administrative and Service Building RCA.

c. <u>System Operation</u>

1. Heating, Ventilating, Air Conditioning System

The air to the central multi-zone air conditioning unit is taken from the outdoors, filtered, conditioned, and distributed to each zone. Cooling of the supply air is provided by water chillers.

The central single-zone air conditioning unit operation is similar to the multi-zone unit except that cooling is provided by a direct expansion refrigerant system that includes a rooftop air-cooled condenser.

The air supplied to the count room, hot chemistry laboratory, and HP check point is humidified by electric duct humidifiers to maintain the desired space conditions.

Sensors provide freeze protection and smoke detection which cause the multi-zone air conditioning unit to be de-energized, the dampers to be closed, and a local annunciator to be energized.

2. Heating, Ventilating System

The central single-zone heating and ventilating unit operation is similar to that of the multi-zone air conditioning unit, except that there is no reheat or cooling coil. The RCA tunnel unit has an electric heating coil with an integral thermostat to maintain the design supply air temperature. The remaining heating and ventilating units are provided with a hot water heating coil and a thermostat and temperature control valve to maintain the design room conditions.

The central multi-zone heating and ventilating unit operation is similar to that of the multi-zone air conditioning unit, except that there is no reheat or cooling coils. Smoke detectors in the hot chemistry laboratory hood exhaust fans will de-energize this air handling unit. A zone damper and a sensor in the supply duct prevent the discharge temperature from falling below 50°F.

3. Chemistry Count Room Air Conditioning System

The air conditioning unit is located within the room. It recirculates, filters, cools, and humidifies/ dehumidifies room air as needed to maintain desired area temperatures and relative humidities. Cooling is provided by a direct expansion refrigeration system which includes an air-cooled condensing unit located on the roof of the Administration Building. A thermostat, humidistat, control valves and switches internal to the air conditioning unit regulate the refrigeration cycle and control equipment operation to maintain desired room conditions. Note that makeup air is still supplied to the count room from the central HVAC system.

4. Exhaust System

The air supplied to the RCA tunnel is exhausted through the PAB filtered exhaust system described in Subsection 9.4.5.

The balance of the air supplied to the RCA for air conditioning, heating and ventilating systems is exhausted after use through monitored absolute filters and radiation monitors. Where no air is supplied directly to a room which is exhausted, or where the air quantity exhausted is greater than that supplied to maintain a negative room pressure, makeup air is infiltrated or directly transferred from adjacent rooms, corridors or outdoors.

Air taken from the rooms is discharged by exhaust fans which operate in a lead/lag sequence, so that if one fan fails, the other is energized automatically. When a no-flow situation is sensed in both fans and both fans are energized, a local annunciator is energized. If the no-flow situation continues beyond a time delay setpoint, the air handlers will be de-energized and the dampers closed. If smoke is detected, the exhaust fans will continue running and the air handlers will be de-energized and the dampers closed.

Air is exhausted from the hot chemistry laboratory fume hoods by exhaust fans. If smoke or high radiation is sensed at any of the fans, they will continue running, and an alarm will be energized at the local panels and in the main control room. The multi-zoned air handling unit will be de-energized, and the dampers will be closed manually.

Mechanical Room 1B is ventilated when required to maintain the space design conditions, or when smoke is detected. A local annunciator will energize upon smoke detection.

In general, if the fans in the exhaust system are removed from service, or fail, all air supply systems will automatically shut down to prevent pressure buildup and the resulting exfiltration of potentially contaminated air to other areas.

5. Chilled Water System

The system is designed to supply chilled water to its respective air handling units. The chilled water is circulated by two pumps in a parallel arrangement to provide 100 percent backup capability. A local annunciator will be energized if either of the pumps is energized and a nonflow condition exists.

Water is chilled by two packaged, automatic liquid chillers operating in parallel. If either liquid chiller fails, the other provides standby service with 50 percent capacity.

Each chiller rejects compressor heat to atmosphere via an associated roof-mounted air cooled refrigerant condenser.

6. Hot Water Heating System

This system is designed to supply heat to offset the heat losses of the building during the winter season and to provide hot water to the RCA air handling units, preheat coils, and reheat coils. Hot water is supplied to the RCA by the Administration and Service Building primary hot water distribution system which pumps water through the building hydronic circuits. The pumps are in a parallel lead/lag arrangement. A no-flow situation or a low compression tank level will energize local annunciators. Primary hot water is distributed on a continuous basis at a maximum temperature of 250°F.

7. Radiation Monitoring

   Area radiation monitors with ranges of 10^{-1} to 10^{4} mr/hr are located as denoted in Subsection 9.4.12.2b.6 to provide local indication and alarms.

   Airborne radiation monitors with ranges of 10^{-12} to 10^{-8} μCi/cc (particulate) and 10^{-7} to 10^{-3} μCi/cc (gaseous) are located in the building exhaust system and provide local and remote indication and alarm. Miscellaneous gross activity airborne monitors with ranges of 10^{1} to 10^{6} cpm, provided with local and remote indication and alarms, are also located in the exhaust system.

9.4.12.3 Safety Evaluation

Since these systems have no safety design bases, no safety evaluation is provided.

9.4.12.4 Inspection and Testing Requirements

Since neither the equipment or the system is safety-related and since the system will be normally operating, no special operational testing or special in-service inspections are required. Manufacturer's certified performance data have been obtained for all fans and coils. Equipment operation and system balancing are accomplished during plant startup.

9.4.13 Service Water Pumphouse Heating and Ventilation System

The Service Water Pumphouse heating and ventilation systems are comprised of the heating and ventilation systems for the pump room area of the Service Water Pumphouse.

9.4.13.1 Design Bases

The pump room area of the Service Water Pumphouse is ventilated by two exhaust fans. The fans are redundant and are capable of maintaining maximum design temperatures (reference Figure 3.11-1) under all normal and accident conditions.

Both switchgear areas are ventilated by one of two full-sized supply fans. Either fan is capable of maintaining both Train A and Train B switchgear areas at or below 104°F when the outside air temperature is 88°F or lower during both normal and emergency plant operation such as during and after an SSE, a loss of offsite power and a single active failure. One fan is powered by ESF Electrical Train A and the other by ESF Electrical Train B.

The pump room area of the Service Water Pumphouse is maintained at 50°F or above when the outside temperature is 0°F or above by a hot water heating system using unit heaters. A heating hot water line break or a failure of the heating system would not affect the operation of the service water pumping equipment.

The switchgear areas are heated with two one-half-sized electric unit heaters in each area. The areas are maintained at 50°F or above when the outside temperature is 0°F or above. Failure of the heating system would not affect the operation of the switchgear.

The ventilation system for the pump room area and the ventilation system for the switchgear areas are designed to meet the intent of 10 CFR Part 50, Appendix A, General Design Criteria (GDC) 2, 4 and 5 and Regulatory Guides 1.26 and 1.29. The ventilation equipment is located in the Service Water Pumphouse, a seismic Category I structure that is missile and flood protected. Tornado protection for ventilation equipment is described in Section 3.3.

See Table 9.4-1 for codes and standards for HVAC system components.

9.4.13.2 System Description

Heating and ventilating equipment performance data are listed in Table 9.4-14. See Figure 9.4-23 for the ventilation air flow diagram.

The pump room area is ventilated and cooled with outside air supplied through pneumatically operated dampers, and exhausted through exhaust fans and backdraft dampers. Each exhaust fan and its associated supply air damper is controlled by a separate thermostat located in the pump room area. The thermostat settings are staggered such that the fans will start in sequence. Each fan is powered by a separate and independent ESF electrical train. Each supply air damper is designed to fail open on loss of air or electric power to its solenoid valve.

The switchgear areas, one for Electrical Train A equipment and the other for Electrical Train B equipment, are ventilated with filtered outside air supplied by one of two full-sized supply fans through a seismically supported duct system. Each fan is powered by a separate and independent ESF electrical train. Air is drawn from the outside through a roll-type filter, a fan, a backdraft damper, and then distributed through ductwork into the two switchgear areas. Air is exhausted from each switchgear area through its respective relief damper. There are two thermostats per fan to control its operation, one in Train A switchgear room and the other in Train B switchgear room. Both the thermostats on the lead fan have identical setpoints.

The pump room area is heated by hot water unit heaters sized and located to maintain the area at or above the minimum design temperature. Hot water is pumped through the unit heaters from a steam-to-hot-water heat exchanger located in the adjacent Circulating Water Pumphouse. The heating system is not required to maintain operation of the service water pumping equipment. A heating hot water line break or heating system failure will not affect the operation of the service water pumping equipment.

The switchgear areas are heated with electric unit heaters. Each area has two half-sized heaters. Each heater has its own single stage thermostat. The thermostat setpoints are staggered for lead/lag operation. A failure of the heating system will not affect the operation of the switchgear.

Instrumentation is provided to alarm on the main control board high/low temperature conditions in the Service Water Pumphouse and switchgear rooms.

9.4.13.3 Safety Evaluation

The power source for each exhaust fan in the pump room area is from separate and independent ESF electrical trains, and loss of air or electric power to the supply air dampers will cause them to fail open. The fans and dampers are safety-related and seismic Category I and, therefore, are designed to function during and following and SSE. Neither loss of offsite power, nor an SSE or a single active failure will prevent adequate ventilation of the pump room area.

The power source for each supply fan providing ventilation to the switchgear areas is from separate and independent ESF electrical trains. The fans and dampers are safety-related and seismic Category I and, therefore, designed to function during and following an SSE. Tornado dampers are provided to protect the intake and exhaust ventilation openings serving the switchgear room. Neither loss of offsite power, and SSE or a single active failure would prevent adequate ventilation of the switchgear areas.

9.4.13.4 Inspection and Testing Requirements

During the preoperational test program, the Service Water Pumphouse heating and ventilation system is balanced and adjusted to design air flow, and system operability, control, and alarm functions are verified. Periodic operability tests of the pumphouse exhaust fans and switchgear room supply fans and associated dampers are performed.

9.4.14 Service Water Cooling Tower Heating and Ventilation System

The service water cooling tower heating and ventilation systems are comprised of a heating system and a ventilation system for each redundant switchgear room and a ventilation system for the pump room. Each switchgear room and the pump room are ventilated by drawing air from, and exhausting to, the outside.

9.4.14.1 Design Bases

The service water cooling tower heating and ventilation systems are designed to prevent temperatures in the pump room and switchgear rooms from exceeding the inside design temperature in the summer and dropping below the inside design temperature in the winter. These design conditions and their associated design bases are given in Figure 3.11-1. The pump room is not provided with a heating system, since the water lines are drained and electrically heat traced in the winter.

The ventilation systems are designed to operate during normal and emergency conditions. The ventilation systems are seismic Category I, Safety Class 3. Motors are Class 1E. Each plant unit redundant switchgear room has its own independent supply fan. The heating system is designed to operate under normal conditions only, is not safety-related, and may not be available under emergency conditions.

The ventilation systems are housed in seismic Category I structures to withstand the effect of flooding. The ventilation systems are not required to operate during a design basis tornado. Flood design is discussed in Section 3.4, and internal and external missiles in Section 3.5. Postulated rupture of piping is not applicable, as there is no piping in the area of the systems. Environmental design of mechanical and electrical equipment is discussed in Section 3.11. The ventilation system sheet metal ductwork is seismic Category I supported to prevent failure and damage to safety-related equipment.

Codes and standards for the system components are presented in Table 9.4-1.

9.4.14.2 System Description

The service water cooling tower heating and ventilation systems are shown on Figure 9.4-23. The pump room and switchgear rooms are located at opposite ends of the service water cooling tower. They are completely independent and identical except that they are opposite hand.

Ventilation and cooling air is drawn into the ventilation and mechanical equipment area of the pump room from the outside through fixed louvers and a roughing filter.

Cooling of the pump room area, when required, is accomplished by redundant exhaust fans. Each fan is controlled by its individual thermostat. Thermostats are set so if one thermostat, fan or its power supply fails, the redundant fan, served by a separate Class 1E power supply, will start before overheating occurs.

Each of the two switchgear rooms is supplied with ventilating and cooling air, when required, from its own independent supply fan located in the mechanical equipment area. The supply air fan for each switchgear room is provided electrical power for a Class 1E power source which is independent of the other three. Each supply fan is cycled by a thermostat located in its respective switchgear room. Supply air is directed to the switchgear room via sheet metal ductwork. Heat-laden air from the switchgear rooms is exhausted through a relief damper to the outside.

Two 50 percent capacity electric unit heaters with external thermostatic controls are located in each switchgear room to maintain the room at or above the minimum design temperature. Heating and ventilating equipment is listed in Table 9.4-15.

The pump room exhaust fans are cycled, as required, by locally mounted thermostats. All fans and associated dampers are controlled from the main control board (MCB). Abnormal temperature conditions (low/high) in the cooling tower pump room and switchgear rooms are alarmed on the MCB.

9.4.14.3 Safety Evaluation

The redundant, seismic Category I, Safety Class 3, pump room exhaust fans, with each fan provided electrical power from a separate Class 1E power source, assure continued ventilation should a single failure occur.

Each redundant switchgear area is ventilated by a separate seismic Category I, Safety Class 3, supply fan, with seismically supported ductwork. Each fan is provided electrical power from a separate Class 1E power source. This will assure adequate switchgear operation should a single failure occur.

9.4.14.4 Inspection and Testing Requirements

During the preoperational test program, the service water cooling tower heating and ventilation system is balanced and adjusted to design air flow, and system operability, control, and alarm functions are verified. Periodic operability tests of the pump room exhaust fans and the switchgear area supply fans are performed.

9.4.15 Turbine Building Heating, Ventilation and Air Conditioning Systems

Heating, ventilating and air conditioning (HVAC) systems are designed to circulate air through the Turbine Building in the summer for removal of the heat loss from all equipment and piping within the area during normal plant operation, and to maintain the temperature within specified design limits during shutdown periods.

The turbine erector's office, electronic work room, startup room, relay room, radio room, Secondary Alarm Station (SAS), and SAS UPS room are air conditioned.

The Turbine Building is heated with steam unit heaters, when necessary, to maintain the minimum inside design temperature during plant shutdown.

9.4.15.1 Design Bases

a. The Turbine Building HVAC systems are designed to heat, ventilate, and air condition when and where necessary to maintain design temperature and humidity conditions.

b. The ventilation systems for the battery room located in the relay room, the main battery room, radio room and SAS UPS room are designed to prevent hydrogen gas buildup.

c. The electronics work room, turbine erector's office, startup room, relay room and radio room are slightly pressurized over ambient to prevent dust from entering those areas.

d. Codes and standards applicable to the Turbine Building ventilation system equipment are listed in Table 9.4-1.

e. The ventilation system for the Lube Oil Storage Building is designed to prevent flammable vapor buildup.

9.4.15.2 System Description

The Turbine Building ventilation system is shown on Figure 9.4-24. There is no safety-related equipment associated with this system. Design data is presented in Table 9.4-19.

a. Turbine Hall and Heater Bay

The turbine hall and heater bay have a total of twenty power roof ventilators, ten for each area. Each area is further subdivided into ten ventilation zones with an operable louver and associated power roof ventilator. The operating louvers are located along the east and south walls of the turbine hall, divided between elevations 21'-0" and 46'-0"; seven louvers (five of these are a double set) at the lower level and ten at the higher elevation. There are also eight additional movable louvers located at elevation 52'.

Air enters the building through the louvers and is circulated up through the upper floor elevations via floor gratings and openings. The air is then exhausted though the power roof ventilators. Equipment details are found in Table 9.4-19.

The louvers are operated by pneumatic actuators controlled by solenoid valves. The solenoid valves, in turn, are controlled through manual/automatic/close switches located at local control panels. When the louvers are in the full open position, the power roof ventilators will operate.

b. Turbine Erector's Office, Electronics Workroom, Startup Room, SAS room and SAS UPS room

The turbine erector's office, electronics work room, startup room, SAS room and SAS UPS room are air conditioned using a split system direct expansion multi-zone air conditioning, ventilating and heating unit with a remote condensing unit. Table 9.4-19 contains design data relating to this system. Figure 9.4-24 shows the air conditioning system.

The multi-zone unit is located in the roof of the area it serves, while the condensing unit is installed on the roof of the Turbine Building heater bay. The multi-zone unit consists of a mixing box with dampers, filter section, centrifugal fan, electric heating and refrigerant coils and a zone damper section.

The air-cooled condenser consists of a condensing coil and fans. This system is manually operated through a local control panel by placing the multi-zone unit switch in the "RUN" position, which causes the fan to run continuously. Individual space thermostats control the zone dampers to provide room temperature control. An enthalpy controller selects the operating mode of the condensing unit, as well as positions the mixing section dampers to allow natural cooling when possible. A minimum outside air position for the dampers permits ventilation air to be drawn in at all times. Whenever one or more of the space thermostats calls for heat, the cooling zone damper(s) will close as the heating zone damper(s) open. If the space thermostat is not satisfied, then the electric heating coil is actuated.

An exhaust fan located in the toilet room exhausts the minimum ventilation air outside the building. A pressure relief damper, located in the electronic work room, prevents excessive pressure in the area.

Self-contained room air conditioning units are provided in Room T-300, T-307 and T-308 as back-ups in the event that 1-TAH-AC-34 is out of service.

c. Relay Room

The relay room has battery rooms associated with it. Table 9.4-19 lists the design data which relates to this system; Figure 9.4-24 diagrams the air conditioning system.

A conventional split system air conditioning arrangement provides heating, cooling and ventilation for the area, including the battery rooms. The air handling unit consists of a mixing damper section, filter section, electric heating coil, refrigerant coils and a fan section. The air handling unit is located on the roof of the relay room.

A remote mounted condensing unit, consisting of a condensing coil and fan, is located on the Administration and Service Building roof.

The system is manually operated from a local control panel. Placing the control switch in the run position starts the air handling unit fan. The mixing dampers, relief dampers and condensing unit are controlled by a thermostat located within the relay room.

Outside air is introduced to the air handling unit to provide makeup air and natural cooling when the outside air temperature permits, in the same manner as the Turbine Erector Office System.

Independent exhaust fans are provided for each of the two battery rooms. The fans are manually controlled from local panels and run continuously.

d. Battery Rooms

The battery room at elevation 21'-0" in the Turbine Building is heated and ventilated using a duct-mounted steam coil and duct-mounted mixing dampers. The mixing dampers, controlled by a temperature controller within the space, modulates to maintain a fixed quantity of outside air while providing heat and cooling to the room. A steam coil located within the same air intake duct provides heat when required. The steam coil is controlled by a space mounted thermostat.

An exhaust fan draws air through the battery room and discharges it outside the building. This fan is controlled manually from a local panel and operation is continuous. The equipment details are included in Table 9.4-19. The ventilation system is shown in Figure 9.4-24.

e. Feed Pump Turbine Rooms, Turbine Lube Oil Tank Room, Turbine Lube Oil Reservoir Room and Elevator Machinery Room

Each of the feed pump turbine rooms, turbine lube oil tank room and turbine lube oil reservoir room, as well as the elevator machinery room, are ventilated by exhaust fans. Air is drawn into each of the rooms, then discharged outside the building. Since the supply air is drawn from the Turbine Building, the rooms listed above do not have an auxiliary heating system. The fans are controlled manually from local control panels.

The performance and equipment data is listed in Table 9.4-19. The ventilation system is diagrammed on Figure 9.4-24.

f. Radio Room

The radio room located above the stairwell enclosure at the north end of the turbine hall at El. 84'-7" is air conditioned by a self-contained rooftop mounted unit. The self-contained unit consists of a compressor, condenser coil and fan, evaporator coil and fan and a filter section.

The temperature in the radio room is automatically controlled. High temperature will be alarmed in the main control room.

g. Lube Oil Storage Building

The Lube Oil Storage Building located on the east side of the Turbine Building is ventilated by an air supply fan. Outside air is discharged from the externally mounted fan into the building air supply ductwork. The fan is designed for continuous operation and is controlled manually from a control switch mounted outside of the building. A steam coil located within the supply duct provides heat when required. The steam coil is controlled by a space mounted thermostat.

Exhaust air leaves the building through four exhaust penetrations. The supply penetration and exhaust penetrations are equipped with UL-approved fire dampers. Loss of air flow is alarmed in the main control room.

The performance and equipment data is listed in Table 9.4-20. The ventilation system is diagrammed on Figure 9.4-24.

h. SAS UPS Room

The SAS UPS room is air-conditioned using a split system ductless air conditioner. The compressor/condenser unit is located outside the south wall of the room, while the evaporative cooling unit with integral fan is located in the room on the north wall. The unit is controlled by a wall mounted remote control unit that is wired to the evaporator and controls all functions of the unit as well as acting as the thermostat. In addition, air conditioning unit 1-TAH-AC-34 provides makeup air to the room to prevent hydrogen gas buildup.

9.4.15.3 Safety Evaluation

The Turbine Building, as well as those subsystems included in the building, and the lube oil storage building have no safety design bases; therefore no safety evaluation is provided.

9.4.15.4 Inspection and Testing Requirements

The Turbine Building Systems and equipment are not safety-related and, since all equipment and systems will normally be functioning, no special operational testing or special in-service inspections are required. Manufacturer's performance data have been obtained for the air conditioning equipment, fans and heating coils. Equipment operation and system balancing are accomplished during plant startup.

9.5 OTHER AUXILIARY SYSTEMS

9.5.1 Fire Protection System

The information presented in Subsection 9.5.1 provides a general discussion of the various fire protection systems at Seabrook Station. In addition, specific reports and information have been provided to address different facets of the fire protection program in greater detail. These documents are:

- Fire Protection Evaluation and Comparison to BTP APCSB 9.5-1, Appendix A Report
- Safe shutdown Capability Report (10 CFR 50, Appendix R)
- Supplementary information identified in PSNH letter (SBN-1102), dated June 11, 1986.

The Fire Protection Evaluation and Comparison to BTP APCSB 9.5-1, Appendix A Report contains the BTP APCSB 9.5-1 comparison to Seabrook Station as well as Seabrook Station's Fire Hazards Analysis. The Safe Shutdown Capability Report provides the analysis of Seabrook Station to the requirements of 10 CFR 50, Appendix R. The supplementary information identifies that correspondence sent to the NRC has been incorporated in the above referenced reports. The information is considered historical and provides further details regarding the Seabrook Station Fire Protection Program. The Appendix A and Appendix R Reports are incorporated by reference into the Updated FSAR.

In addition to the above, limiting conditions for operation, action statements and surveillance requirements for the Fire Protection Program are prescribed in the Seabrook Station Technical Requirements Manual, and have been established within Seabrook Station plant operating procedures.

9.5.1.1 Design Bases

The plant fire protection system is a nonsafety-related system designed to detect and alarm, control and extinguish fires that may occur. To accomplish this end, the concept of defense in depth is a criterion for design. This concept, applied to fire protection, aims at a balanced program which will:

a. Prevent fires from starting.

b. Detect fires quickly, and quickly suppress those that occur, thus limiting their damage.

c. Design and locate plant equipment such that if a fire occurs and burns for a long time, despite a. and b., that essential plant activities will still be performed.

d. Ensure that neither inadvertent operation nor failure of a system will induce a failure of any safety-related system.

The guidance provided by APCSB BTP 9.5-1 and its Appendix A and 10 CFR 50 Appendix R is utilized in meeting the design basis.

The fire protection systems have been designed using the general guidelines of the following codes and standards:

- American Nuclear Insurers (ANI) - Specification for Fire Protection of New Plants, prior to November 15, 1997. Nuclear Electric Insurance Limited (NEIL) - Primary Property Insurance Manual, beginning November 15, 1997.
- National Fire Protection Association (NFPA) and ANS Codes as listed in Table 9.5-1
- Uniform Building Code (UBC).

Equipment in the fire protection systems, except for the following, conforms to the standards of the National Fire Protection Association, and is Underwriter's Laboratory (UL) listed and/or Factory Mutual approved:

- Fire tank and fire tank heating systems
- Hydrant isolation valves
- Low point drain valves in sprinkler systems
- Test flow meter for fire pumps
- Fire protection booster pump
- Isolation valves in seismically designed standpipes
- Butterfly valves in fire pump test/relief return line
- Charcoal filter fire detection or system.
- Globe valve in the fire protection booster pump discharge test connection.

9.5.1.2 System Description

a. Fire Prevention

The plant fire protection system utilizes design aspects which employ separation criteria, noncombustible material, fire barrier divisions, fire rated penetrations for conduit, cable, piping and ductwork, as well as fire dampers. Fire barrier floors and walls, including all penetrations, have a design fire rating commensurate with the hazard. Physical separation or fire barriers are provided between redundant systems or equipment. In addition, fire stops are provided in long vertical cable tray runs to further ensure the non-propagational properties of the cables. These fire stops are provided where no other fire barriers exist. Electrical separation criteria between divisions is described in Subsection 8.3.1.4.

Plant equipment location and separation to limit fire-related damage is discussed in detail in the report "Seabrook Station Fire Protection System Evaluation and Comparison to Branch Technical Position 9.5-1, Appendix A" and "Fire Protection of Safe Shutdown Capability (10 CFR 50, Appendix R)."

b. Detection Systems

Fire detection devices are provided in areas which are judged to contain sufficient combustibles to present a fire hazard.

Fire detectors are installed consistent with the type of fire anticipated. A minimum of two detectors of any type are provided in each fire zone or fire area. Failure of one detector will not affect the operability of any other detector. The detectors are positioned within the zone or areas so that the flow of air or pressure differences will not affect proper operation of the detector.

The fire detection system contains supervisory panels to monitor the detector status. Fire detectors alarm at the control console in the control room to provide rapid identification of the location of any fire so that corrective action can be initiated.

Table 9.5-2 identifies the fire detector types for buildings and structures. Technical Requirement 12, located in the Technical Requirements Manual, lists the minimum number of functional detectors in each fire area.

Charcoal filter fire detection systems sense carbon monoxide to provide an early warning of a fire within the charcoal filter bed being monitored. Each charcoal filter located outside of containment is monitored by sample probes which are located both upstream and downstream of the charcoal beds. Control modules process signals from the sample probes and initiate alarms to the Fire Detection System upon detection of a high carbon monoxide concentration. Within containment, filter CAH-F-8 is monitored by a self-contained Sample System which draws a sample from the downstream side of the charcoal filter. The Sample System initiates an alarm to the Fire Detection System upon detection of a high carbon monoxide concentration. Alarms are initiated by the Fire Detection System on the fire control panel located in the control room.

c. <u>Suppression Systems</u>

Fire suppression capability is provided by installed systems which include water supply, pumps, valves and piping that supply hose stations, wet and preaction sprinklers, and deluge spray systems. Portable fire extinguishers are provided, where appropriate, and installed gas suppression systems are used where water would cause a hazard to equipment or personnel.

1. Water Supply

The fire protection system is shown schematically in Figure 9.5-1, Figure 9.5-2, Figure 9.5-3, Figure 9.5-4, Figure 9.5-5, Figure 9.5-6, Figure 9.5-7 and Figure 9.5-8. The water supply for the plant fire protection system is obtained from two 500,000-gallon heated water storage tanks, of which 300,000 gallons in each tank is reserved for fire protection. Water for fire protection is supplied to the system by one 1500-gpm motor-driven centrifugal fire pump and one 1500-gpm diesel engine-driven centrifugal pump which provide the system design capacity. A second 1500-gpm diesel engine-driven centrifugal fire pump is provided as a spare. Each pump is capable of taking suction from either tank.

Two 25-gpm motor-driven centrifugal pressure maintenance jockey pumps maintain fire system pressure, and prevent unnecessary starting of the main fire pumps.

The fire pumps and jockey pumps are housed in a pumphouse adjacent to the fire tanks. The pumphouse is heated and ventilated to maintain suitable ambient conditions for pump operation. Each fire pump is separated by a three-hour rated fire barrier wall, with each bay containing sprinklers and combination fixed temperature rate-of-rise detectors or ionization detectors which alarm at the main control board.

Electric power for the motor-driven fire pump and jockey pumps is obtained from a 460-volt load center. An alternate feed from a second 460-volt load center is supplied to the main motor-driven fire pump.

2. Yard Piping

Fire protection water is supplied to the plant via a closed loop main. The fire main is a 12-inch cement-lined steel piping system, coated and wrapped on the outside for corrosion protection or, Fibercast, Factory Mutual (FM) approved, Class 1614, pipe. The fire pumps are arranged to discharge to either half of the loop, with provisions included to permit both pumps to discharge into either half of the loop, if a portion of the main is out of service.

Each branch line from the fire main is equipped with a normally open post-indicating valve. Additional, normally open post-indicating valves are installed in the main to permit isolation of individual main sections for service or repair without affecting the operation of the balance of the main system.

3. Yard Protection

Fire protection is provided to the exterior plant areas by fire hydrants located along the loop at about 250-foot intervals. Hose houses are provided complete with necessary associated accessories at alternate hydrant locations. Hydrants are located to provide coverage for each building.

4. Deluge Systems

Hydraulically designed, automatic deluge systems are provided in the following areas containing safety-related systems or equipment:

- Diesel Generator Building fuel oil day tank area
- Control Building cable spreading area.

Hydraulically designed, automatic deluge systems are provided in the following areas housing nonsafety-related equipment:

- Generator step-up transformers
- Unit auxiliary transformers
- Reserve auxiliary transformers
- Feed pump turbine lube oil conditioner
- Hydrogen seal oil unit
- Main turbine lube oil conditioner and oil reservoir
- Hydraulic fluid power unit
- Turbine lube oil storage tank.

Each deluge valve system contains an automatic deluge valve, system actuation detectors, supervisory control panel with local flow indication provisions included, and remote annunciation at the control console in the control room. The deluge valves and manual actuators are located in areas remote from the protected areas. The systems are provided with 24-volt DC power for operation, should main power be unavailable.

5. Wet Pipe Sprinkler Systems

Wet pipe sprinkler systems are installed in the following nonsafety-related areas:

- Turbine Building below turbine generator operating floor elevation 75'-0" and below the mezzanine floor elevation 46'-0" and 50'-0"
- Turbine Building heater bay below the roof and below floor elevation 50'-0"
- Administration Building Storage Area
- Steam generator feed pump areas
- Lube Oil Storage Building
- Diesel Generator Building sump
- Mechanical Maintenance Storage Facility

- Leased Makeup Water Treatment System room and Administration Building Storeroom
- Administration Building (first floor)
- Chlorination Building
- Condensate Polisher Facility
- Alternate RP Checkpoint

Wet pipe sprinkler systems are provided with heat-actuated, closed head, fusible sprinklers with a local flow-actuated alarm. The flow alarm will cause the annunciation of a fire condition in the control room.

6. Preaction Sprinkler Systems

Preaction sprinkler systems are installed in the following safety-related areas:

- Cable tunnels from Control Building to containment
- Cable tunnels from Control Building to Primary Auxiliary Building
- Electrical penetration areas outside containment
- Primary Auxiliary Building at elevation 25'-0" and the electrical chase
- Diesel Generator Building fuel oil storage tank rooms and the fuel oil piping trenches.

Preaction sprinkler systems contain valve actuation provisions from fire detectors to charge the system with water, which will then discharge from any sprinkler head fused-open by a fire. Fire detection is annunciated at the control console in the control room and on a local control panel.

Note: The non-safety related RCA Storage Facility also has a preaction sprinkler system.

7. Manually Operated Pre-Action Sprinkler Systems

Manually operated sprinkler systems are provided for the following areas: (a) turbine generator bearings, (b) lube oil piping from bearings to guard pipe and (c) diesel generator rooms.

Manual operated sprinkler systems are provided for the Supplemental Emergency Power System enclosures (each diesel generator and switchgear enclosure). Water is supplied to the sprinkler piping from a fire hydrant utilizing fire hose.

Fire detectors in the area annunciate a fire condition at the control console in the control room and on a local control panel.

8. Standpipe Systems

The Turbine Generator Building, the Mechanical Maintenance Storage Facility, the Administration and Service Building, Containment, Control Building, Primary Auxiliary Building, Fuel Storage Building, Waste Process Building, RHR equipment vault, Diesel Generator Building and emergency feedwater pump area are provided with fire hose stations at approximately 100-foot intervals around or within the building or stairwells to provide coverage, using 100 feet of hose. Each hose station consists of 1½ inch hose with Factory Mutual approved accessories.

The Turbine Generator Building hose stations are supplied from two looped building mains fed from two branch lines supplying the building from separate sections of the 12-inch yard fire main.

Two branch lines from separate sections of the yard fire main, backed up by a branch line from the safety-related plant service water system and booster pump, supply water to the standpipe hose stations in the RHR equipment vault, Primary Auxiliary Building, Fuel Storage Building, Diesel Generator Building, Control Building, and emergency feedwater pump area. These systems are designed to be operational following an SSE.

To provide increased reliability for cooling safety-related components, a crossconnect from the Fire Protection and Demineralized Water systems to the PCCW System is included in the system design. This crossconnect can be used to provide cooling water to the charging pump lube oil coolers or provide emergency makeup water to safety-related portions of the PCCW System. This crossconnect is backed up by a seismic Category I Service Water System and booster pump makeup source.

Standpipes in safety-related areas are designed and supported as seismic Category I systems to prevent pipe failure and subsequent pipe whip. This feature also applies to deluge water spray and preaction sprinkler systems installed in safety-related areas.

Table 9.5-2 identifies the areas provided with hose stations.

9. Portable Fire Extinguishers

Portable fire extinguishers are located throughout the plant as the primary fire-fighting provisions in those areas determined to have negligible fire hazard, and as secondary defense in areas containing fixed fire protection systems. Portable fire extinguishers were selected on the basis of the most suitable type for the hazard present, with the radiological, metallurgical, physical and chemical compatibility of the extinguishing agents with plant components in mind. The types of portable extinguishers provided are pressurized water, Halon 1211, dry chemical and CO_2.

The extinguishers are conveniently located and conspicuously marked. Table 9.5-2 identifies the type of extinguishers provided in the plant.

10. Halon 1301 Fire Extinguishing Systems

A Halon 1301 fire extinguishing system is installed in the following nonsafety-related area:

- Main computer room (in Control Building)

Halon 1301 systems contain valve actuation provisions from fire detectors to discharge the gas for total flooding of the area experiencing a fire. Fire detection is annunciated at the control console in the control room and on a local control panel. The detection system also contains provisions to close all doors, and to close dampers in the air supply and ducts to the rooms, thus isolating the affected area from adjacent rooms.

9.5.1.3 Safety Evaluation (Fire Hazards Analysis)

A systems approach is used in evaluating the requirements for preventive and protective measures. These requirements are based upon a determination of the potential fire hazards existing in the various areas of the plant, all as delineated in the report "Seabrook Station Fire Protection System Evaluation and Comparison to Branch Technical Position APCSB 9.5-1, Appendix A," and "Fire Protection of Safe Shutdown Capability (10 CFR 50, Appendix R)."

The basic plant design uses noncombustible materials of construction, physical separation of systems and equipment, fire barrier walls, or spatial separation within a fire-rated enclosure, to insure that a fire within any area will not affect redundant equipment or an adjacent area. The fire protection systems, as installed, utilize rapid detection and actuation features to initiate the fire protection systems in high fire potential areas to extinguish the fire quickly and effectively. In areas containing slight fire potential, the alarm system provides rapid annunciation to the plant operator for prompt dispatch of personnel to extinguish a small fire.

The system, as designed, ensures that any fire in a safety-related area will not affect any adjacent area and the safe shutdown capability of any system or component.

The following features are incorporated in the design of the fire protection system:

a. A motor-driven fire pump and a diesel engine-driven fire pump are provided to satisfy the system design capacity. A second diesel engine-driven fire pump is included to function as a spare. Each fire pump is provided with an individual line pressure-actuated controller. Each controller is equipped with manual start provisions, and is provided with system malfunction or trouble alarms to alert plant operators of the operational status of each pump. Power to the motor-driven fire pump system is provided from two separate sources, with manual switchover between power feeds. Provisions are included for periodic testing of the fire pumps.

b. Each fire pump takes suction from two 500,000-gallon water storage tanks, with 300,000 gallons in each tank reserved for fire protection.

c. Each fire pump discharges independently to the plant fire loop. All pumps can be valved to feed either side of the fire loop.

d. Plant fire hydrants are located along the fire main within 40 feet of all building exteriors, wherever possible, to provide convenient access for building protection. The fire main is equipped with sectionalizing post-indicating valves to isolate portions of the main for service or repair, and to maintain the active status of the remaining portions.

e. The Diesel Generator Building fuel oil storage tank area and fuel oil piping trenches are provided with preaction valve fire protection systems. The fuel oil day tank area is provided with a deluge fire protection system. The areas housing the tankage are three-hour rated fire areas with three-hour rated penetrations. A fire occurring in any of these areas will be rapidly detected by the fire detection system which actuates the preaction or deluge valve permitting the water to flow into the system and discharge from any sprinkler head opened by the fire. The preaction or deluge valves are capable of manual actuation.

   The deluge valve system is supplied with 24 DC power as backup to the 120V AC power to ensure system functionality.

f. The cable spreading area in the Control Building, which contains large quantities of cable, is provided with zoned deluge valve fire protection systems. Smoke and thermal-type detectors are provided in the area to ensure detection of any fire. The detection system, in conjunction with the rapid response of the deluge system, ensures the extinguishment of any fire well within the time rating of the cable area fire walls. The deluge valves have provision for manual actuation. The deluge valve system is supplied with 24V DC power as back up to the 120V AC power.

g. The electrical tunnels containing cables from the Control Building to containment and to the PAB are provided with preaction systems. Smoke detectors are provided in the areas to alarm and actuate preaction valves, permitting the water to flow into the system and discharge from any sprinkler head opened by the fire.

h. The control room complex is provided with portable Halon extinguishers for fire protection. The control room is constantly manned, ensuring rapid detection and suppression of any fire. Smoke detectors are also installed for fire detection in the control room. Self-contained breathing apparatus is provided to permit plant operation and fire fighting should smoke become a problem. Standpipe hose reel stations located in the stairwell outside the control room and in the Turbine Building provide backup fire protection for the control room complex.

i. The 4 kV switchgear area, including DC switchgear, CRD MG sets and battery rooms, has three-hour fire rated walls. Each equipment room or area is provided with smoke detectors for rapid fire alarm. Primary fire protection is accomplished with portable extinguishers, backed up by standpipe hose reel stations located outside of the area protected.

j. The cooling tower switchgear rooms and the Service Water Pumphouse electrical control rooms are provided with smoke detectors. The areas are protected with portable extinguishers since the magnitude of a design-basis fire does not warrant fixed fire protection in these areas. In the unlikely event of a continuing fire, yard hydrants and hoses are available for backup suppression.

k. Areas not containing sufficient quantities of combustible materials to warrant installation of fire detectors are identified in the PSNH report "Seabrook Station Fire Protection Program Evaluation and Comparison to BTP APCSB 9.5-1, Appendix A."

l. All fire protection systems in areas containing safe shutdown equipment with the exception of the systems listed in Section 4.0, are preaction systems to preclude inadvertent system trip. Piping in the safe shutdown equipment areas is seismically supported. Drains are provided in these areas to convey any fire protection water away from the fire zone.

m. The status of all fire detection circuits is provided at the control console in the control room and on a local control panel. Alarm, detector malfunction, or detector removal are annunciated for operator action.

n. The plant communication system is available to alert personnel of a fire, its location, and remedial action required.

o. A failure modes and effects analysis for the systems and components is described in Table 9.5-3.

p. The seismically designed Lube Oil Collection System for the four reactor coolant system pumps has been designed with two collection tanks, with two pumps draining to each tank. Each of the two tanks has been sized to contain 125 percent of the oil inventory of one pump. A seismically designed dike has been provided around each tank. Each tank in combination with its associated dike has been sized to contain the entire inventory of two pumps. The tanks and the dikes have been located so that the excess oil does not present a fire hazard to any safety-related equipment. Additionally, there is no ignition source near the diked area.

9.5.1.4 Inspection and Testing Requirements

a. Preoperational Testing

1. Automatic systems (wet pipe sprinkler, preaction sprinkler, deluge water spray) are inspected and tested using the general guidelines of NFPA-13 and 15.

2. Yard piping, standpipes and hose stations (excluding the hoses) are hydrostatically tested to a pressure of 200 psig for a period of 2 hours using the general guidelines of NFPA-13 and 14. Fire hoses are tested and maintained using the general guidelines of NFPA-1962.

3. Fire pump field acceptance tests are performed using the general guidelines of NFPA-20.

4. Halon 1301 systems are tested and inspected using the general guidelines of NFPA-12A.

5. The presence of the NEIL representative is requested for the final inspection and tests of completed installations.

b. Surveillance

Inspections of fire protection equipment are made with filled out reports reviewed by Plant Engineering in accordance with the work control process and filed for examination by a NEIL representative.

9.5.1.5 Personnel Qualification and Training

a. Overall Responsibility for Nuclear Plant Fire Protection

The ultimate responsibility for the overall fire protection program rests with the Site Vice President. The responsibility for the fire protection program has been assigned to the Director - Engineering. The program responsibilities have been delegated to:

1. Manager, Design Engineering - responsible for the technical adequacy of the Fire Protection Program and the licensing and design of fire protection systems and components. The corporate fire protection engineer is responsible for establishing and coordinating the implementation of the program under the Manager, Design Engineering.

2. Manager, Plant Engineering – responsible for the technical oversight of the operation and maintenance of fire protection systems, components and equipment.

3. Station Director - responsible for the implementation of the fire protection program within the protected area, as well as the Fire Pumphouse, tanks and yard piping outside the protected area.

4. Director of Support Services - responsible for the implementation of the fire protection program for those areas outside the protected area not within the scope of the Station Director.

United Engineers & Constructors performed the design and selection of the fire protection systems for Seabrook Station, assisted by Yankee Atomic Electric Company. United Engineers was responsible for the construction of the systems; Yankee Atomic Electric Company was responsible for the preoperational inspections and tests. The qualifications of those persons responsible for the re-evaluation of the fire protection program proposed for Seabrook Station against the guidelines provided in Appendix A to Branch Technical Position APCSB 9.5-1 and Appendix R to 10 CFR 50 are contained in the Seabrook Station Fire Protection System Evaluation and Comparison report.

The Station Director had been authorized to implement the fire protection program for the Site Vice President using the station staff organization.

A general description of the station staff responsibilities for fire protection is as follows:

1. Station Fire Protection Supervisor - responsible for implementation for the station of the fire protection program, as directed by the Station Director.

2. Manager Nuclear Training - responsible for the fire fighting training program for employees.

3. Station Fire Brigade - responsible for fire fighting in the station.

   In addition, the station staff is very active in fire protection and safety activities. Station personnel receive some training in manual fire fighting techniques, and are continually reminded of the importance and methods of fire prevention. Regular safety meetings are held for station personnel, and regular training sessions and drill sessions are held for the station fire brigade.

   The station insurers, Nuclear Electric Insurance Limited, is considered to be an integral part of the station's fire prevention program. Frequent routine inspections of the station are performed by NEIL. Their comments and suggestions are carefully considered by the station staff, and changes are made in the fire protection program or in fire protection systems if they are needed.

b. <u>Fire Protection Training</u>

A training program and schedule have been established for Seabrook Station to develop and maintain an organization fully qualified to be responsible for the fire protection program at the station. The training program schedule is such that a fully trained and qualified fire brigade are available in the necessary numbers required to ensure the fire protection needed for safe and efficient operation of the facility. A continuing program is used for the training of replacement personnel and for any requalification training necessary to ensure that personnel remain proficient. The training program has been formulated following the guidance provided in the NRC document entitled "Nuclear Plant Fire Protection Functional Responsibilities, Administrative Controls, and Quality Assurance." A summary of the training programs follows here. A more detailed discussion can be found in Section 13.2.

1. Plant Staff Training Program

Selected plant staff receive periodic training in manual fire fighting techniques, using the various types of fire extinguishers available in the plant. Regular safety meetings are held, where discussion of the plant fire protection program takes place. All personnel involved with any open flame processes are instructed in the procedures governing this type of work.

2. Plant Fire Brigade

Plant fire brigade personnel are thoroughly trained and drilled in use of all fire fighting and suppression equipment in the plant. They receive yearly training sessions, and have periodic drills where the results of that training can be tested and demonstrated. In addition, the fire brigade leader receives special training in fire fighting tactics and fire "size-up."

3. Coordination With Local Fire Departments

Although the plant will be well protected with respect to fire fighting capabilities, local fire department support will be called upon for backup. The plant fire protection training program will include the local fire departments' personnel where practicable.

9.5.2 Communications Systems

9.5.2.1 Design Basis

a. The design basis for the plant communications system is to provide a dependable system that will ensure reliable communications during normal plant operation and during emergency situations, including fire, accident conditions and loss of offsite power.

b. The communication system is nonsafety-related. Reliability is assured by providing primary and backup systems that are sufficiently independent of each other so that a failure in one system will not affect the other systems.

9.5.2.2 System Description

Intraplant communications include a private branch exchange (PBX) telephone system, a public address and page/talk system, a two-way radio system, and a sound-powered telephone system. Interplant and offsite communications include a telephone system with offsite communication links and a two-way radio system.

A complete description of the communications for emergency conditions is provided in the Radiological Emergency Plan (Section 13.3).

a. Intraplant Communications

1. Telephone System

A PBX system provides two-way telephone communications between all areas of the plant. Telephones are installed in the control room and all other plant areas to provide the primary means of communications between plant personnel.

The telephone system can access the public address system for paging.

The telephone system can access the trunked radio system via a telephone interconnect.

Power for the telephone system is backed up by a UPS and/or diesel generator.

If all power is lost to the PBX, a number of pre-selected extensions will be automatically connected to the public telephone network. A number of pre-selected site telephones are always connected to an alternate offsite network.

Wiring for the telephone system is carried in Train A instrument cable raceways that are different from those carrying the public address system wiring.

2. Public Address System

A public address (PA) system provides communication between the control room and various plant buildings and areas. The system also provides two-way communications between two or more locations. Speakers and telephone type handsets are installed at locations vital to operation of the plant. The system design includes a feature that allows any site telephone access to the PA system for paging by dialing a special access code. However, this feature is not normally used and is disabled by a cutout switch in the control room.

The type and power handling capability of each speaker are suitable to its location and the background noise at that location. In most plant areas, the paging messages are intelligible above the noise in the area served by the speaker or speakers. In some high noise areas, the paging messages are not intelligible above the background noise. All handsets are provided with four separate channels, one for paging and three for talking.

A multi-tone generator is connected to the paging channel. One tone is for "immediate evacuation," and another is for fire alarm. The control room has a central panel for supervision of the system and for the push-buttons for the tone generator. The "immediate evacuation" tone satisfies the requirements of Regulatory Guide 8.5. The "immediate evacuation" tone is audible in all areas of the plant, except for a small number of high noise areas. In these areas, beacon lights are utilized to provide the evacuation signal.

The PA system is supplied from a UPS bus. Cables for the PA system are run in Train A control cable raceways that are different from those used for the telephone system.

3. Sound Powered Telephone System

A sound-powered telephone system has been provided.

The system has multiple channels which are wired back to a switching panel located in the control room. During refueling, one channel will be dedicated for that operation. One additional channel is dedicated to remote safe shutdown.

All sound-powered telephones are Train A associated. Wiring is run in the Train A instrumentation raceway system. Jacks and wiring installed in Train B panels and equipment have been analyzed to show that it is acceptable for the Train A associated sound powered telephone wiring to be in-contact with Train B wiring.

When two or more handsets or headsets are plugged into jacks on the same loop or on two loops that are patched together, voice communication is established between the two sets.

Handsets and headsets are stored and issued as required. Each remote safe shutdown station has a headset stored in a convenient location.

4. Station Radio System

(a) VHF System

This system is used for two-way communications with mobile and portable vehicles assigned to radiological survey teams.

Remote control consoles exist at the Station control room, the Technical Support Center, the Operational Support Center and the Emergency Operations Facility. These locations control onsite and offsite VHF radio base stations in a single frequency simplex transmission mode of operation.

(b) UHF Radio System

A UHF trunked radio repeater system is used for onsite two-way communications by station Operating, Maintenance, Fire Fighters, Health Physics, and Security personnel. Trunking is the process where a trunking controller automatically selects the channel/repeater when a user keys a portable radio or base station. The trunking controller automatically selects the communication path rather than the user having to manually switch channels to find a clear channel. Should a trunked repeater fail, the trunking controller will allow the user to continue communication almost without knowledge of the repeater failure and without termination of the communication. Should the trunking controller fail, the system reverts to operation similar to a conventional repeater system where users are assigned a specific repeater. For a failure of all the fixed radio equipment (trunking controller, repeaters, and RF mixing rack), communications can be maintained by manually switching the control stations and portables to the TALKAROUND (direct) mode. This mode has reduced coverage since the repeaters are not in service. Trunking greatly improves the reliability of the entire system and allows individual repeaters to handle traffic from any user group if other repeaters are in use or inoperable. The programmable features of the system allow the creation of various user talk groups and priority levels.

A conventional radio repeater is provided as a telephone system interconnect. This allows the radio system to access the telephone system, or vice versa. This capability only exists for those portable radios that are programmed for this feature. Another conventional repeater is provided as a paging system interconnect to activate onsite pagers.

The radio system equipment is powered from the nonsafety power system. Backup power for the trunking controller, repeaters, and RF mixing rack is provided by an emergency diesel generator and by a dedicated battery rated for 2 hours. Other fixed radio equipment such as control stations and control consoles are provided with backup power from an emergency diesel generator backed or UPS backed sources, or a dedicated battery rated for 2 hours. Control consoles located at the Health Physics (HP) Alternate Checkpoint are not provided with backup power. Portable radios can operate independently of all other systems. They are backed up by their own batteries for continued operation in case of loss of all AC power.

Remote control consoles are located at the main control room, the Technical Support Center (TSC), the Health Physics/Operational Support Center (HP/OSC), and the HP Alternate Checkpoint.

(c) Security System

For a description of the system features provided for Security, refer to the Security Plan.

b. <u>Plant to Offsite Communications</u>

1. Telephone System

Various public telephone systems, technologies, and interconnections are utilized to provide an offsite communications capability throughout the plant. In essential areas (e.g. Control Room), several offsite communications systems are available. These systems were selected to ensure that offsite communications remains available, in various failure modes (e.g. loss of on-site power, loss of connectivity to the local telephone company office, loss of the facility that houses the station's primary communications hub).

2. Microwave System

The plant is provided with microwave service from a private network. The channels on the microwave system are used to support Auto Ring Down (ARD) link to the system dispatcher at ESCC in Manchester, NH, Auto Ring Down (ARD) link to the generation dispatcher at ISO-NE Dispatch Center in Holyoke, MA. The microwave equipment and its power supply equipment are located in the Relay Room.

The ARD phones provide automatic connections between the Control Room and the ESCC system dispatcher in Manchester, NH, and ISO-NE generation dispatcher in Holyoke, MA. Various site phones are directly connected to an off-premise PBX using the microwave system.

The power supply consists of a (48V) DC battery and a battery charger connected to an AC distribution panel. If AC power to the charger is lost, the microwave equipment will continue to operate for a minimum period of eight hours.

3. Nuclear Alert System

A complete description of the Nuclear Alert System is provided in the Radiological Emergency Plan (Section 13.3).

9.5.2.3 Evaluation

a. Intraplant Systems

The Intraplant Communications System, i.e., PBX telephone system, PA system, sound-powered telephone system and two-way radio system, are designed to provide the required intraplant communications during and after accident conditions, as well as for plant operation and maintenance.

Failure of any one of the above systems does not result in failure of any other system.

Power to the telephone system is backed up by a UPS and/or diesel generator. The PA system derives its power from a UPS bus. A number of pre-selected phones operate independently of the PBX which would be operated in case of loss of power to the PBX.

Cables for the telephone and PA systems are carried in different raceways.

The sound-powered telephone system does not require any power for operation.

The UHF radio system equipment is powered from the nonsafety power system. Backup power for the trunking controller, repeaters, and RF mixing rack is provided by an emergency diesel generator and by a dedicated battery rated for 2 hours. Other fixed radio equipment such as control stations and control consoles are provided with backup power from an emergency diesel generator backed or UPS backed sources, or a dedicated battery. Control consoles at the Health Physics (HP) Alternate Checkpoint are not provided with backup power. Portable radios can operate independently of all other systems. They are backed up by their own batteries for continued operation in case of loss of all AC power.

b. Plant to Offsite Systems

The various interplant communications systems, i.e., telephone system, microwave link and two-way radio systems, are designed so that each one can provide reliable offsite communications in all cases of emergencies. All systems can operate independently of each other. Failure of one system will not affect the others.

The telephone system has various offsite connections. These include the trunk lines to the public network, private network tie-lines and long distance carrier lines.

The microwave link has two transceivers, one active and one in hot standby mode. Its AC power source is backed up by the equipment's own DC batteries for continued operation for a minimum period of eight hours in case of loss of all AC power.

The radio transceivers can operate independently of all other systems. They are all backed up by their own batteries for continued operation in case of loss of all AC power.

9.5.2.4 Inspection and Testing Requirements

All communications systems are inspected and tested at the completion of the installation to ensure proper coverage and audibility under maximum plant noise levels during various operating conditions. Since the communications systems are used on a daily basis, periodic testing is not required.

9.5.3 Lighting System

The lighting system consists of the normal lighting system, the essential lighting system and the emergency lighting system.

9.5.3.1 Design Basis

a. The normal lighting system is designed to provide sufficient illumination to permit normal plant operation and maintenance functions.

b. The essential lighting system is designed to permit orderly plant shutdown following loss of offsite power. Reduced lighting is provided in control locations.

c. The emergency lighting system is designed in accordance with the requirements of 10 CFR 50, Appendix R, Section III. J, with deviations as noted in Subsection 9.5.3.2c. The emergency lighting system provides adequate lighting for continued operation in those areas of the plant that may need to be manned for safe shutdown operations and in access and egress routes to and from all such fire areas following the loss of the normal and essential lighting systems. Portions of the emergency lighting system, not associated with Appendix R requirements, provide egress lighting for the balance-of-plant areas.

d. The lighting systems are not Class 1E; however, in seismic Category I buildings the mounting of lighting transformers and panels and lighting fixtures is seismically analyzed to ensure that their failure could not damage safety-related equipment.

9.5.3.2 System Description

a. Normal Lighting System

The normal lighting system is fed from local 120/240 volt lighting distribution panels located in the various buildings. These local lighting panels are fed from locally mounted distribution transformers which are connected to the respective building motor control centers. Receptacle circuits are fed from the local lighting panels as required.

The 480-volt feeders to the local transformers are routed in the Plant Raceway System as Train A associated circuits. Branch circuits use aluminum sheath cable (ALS) throughout the plant except in the Guard House, Administration Building and the containment, where branch circuits use cable in electrical metallic tubing (EMT) and rigid steel conduit, respectively.

Incandescent lamps are used in the Containment Building and areas of the PAB and WPB where mercury is restricted. Aluminum fixtures are also restricted from the containment. However, high pressure sodium vapor lamps (containing a mercury-sodium amalgam) which have a double, water impermeable barrier, may be used in containment and the FSB during refueling outages, or if SFP fuel movement/inspection is needed during the fuel cycle. These high intensity lamps provide improved lighting with negligible possibility of contaminants reaching reactor water or components, when used in a temporary capacity as described here.

Normal lighting intensity levels, in general, are in accordance with the guidelines of the Illuminating Engineering Society handbook.

b. Essential Lighting System

The essential lighting system is generally fed from local 120/240 volt AC lighting distribution panels. These panels are fed from locally mounted distribution transformers which are connected to motor control centers. These motor control centers are energized from the diesel generator following a loss of offsite power.

The essential lighting system provides a reduced but adequate illumination for operation in the control room, the emergency switchgear rooms (including the remote shutdown locations), the diesel generator rooms, emergency feedwater pump room and the first aid area in the Administration Building. A minimum lighting level is provided in other selected areas for egress or minimum access.

Power for the dual aircraft warning lights (located on the top of containment) and the perimeter security fence lighting is provided from the Train A associated essential lighting system.

c. Emergency Lighting System

In compliance with 10 CFR 50, Appendix R. Section III.J, 8-hour battery-powered emergency lighting is provided for the areas (listed below) which are needed for operation of safe shutdown equipment and for access and egress routes thereto. Deviations to the 8-hour battery-powered emergency lighting are taken for the main control board area in the control room and for specific motor control centers in both the Train A and Train B switchgear rooms. In these areas, credit is taken for the diesel generator-powered essential lighting.

Areas Required to be Manned for Safe Shutdown Operations

1. Main control room, Control Building, El. 75'-0"
2. Mechanical equipment room, Control Building, El. 75'-0"
3. Emergency switchgear rooms A and B, Control Building, El. 21'- 6"
4. Emergency diesel generator rooms A and B, D.G. Building, El. 21'-6"
5. Nonessential switchgear room, El. 21'-6".
6. Condensate storage tank, valve area, El. 23'-0"
7. Nonradioactive mechanical penetration area, El. 11'-2½"
8. Charging pump cubicle area, Primary Auxiliary Building, El. 7'-0"
9. Boric acid tank room, Primary Auxiliary Building, El. 25'-0"
10. PCCW heat exchanger area, Primary Auxiliary Building, El. 53'-0".

In addition, portions of the emergency lighting system are powered from the two nonvital station batteries as a backup to the essential lighting system.

Selected emergency lighting circuits are automatically energized from the batteries upon loss of all alternating current power sources, including the short period before the diesel generators accept load in the event of a loss of offsite power.

Self-contained 1½-hour battery-powered emergency lighting units are provided in those areas of the plant, not covered under Appendix R requirements, where the plant DC system is not available.

9.5.3.3 Failure Analysis

The essential lighting system is powered from both Train A and Train B diesel generator-supplied motor control centers. In the control room, emergency switchgear rooms and diesel generator rooms, the fixtures are supplied for both trains. Failure of either diesel generator to start in the event of loss of offsite power will not result in total loss of the essential lighting in these areas.

During the period between loss of offsite power and load acceptance by the diesel generators, minimum lighting is provided from the emergency lighting system from either the nonvital station batteries or from lighting battery packs.

The Seabrook lighting system has been designed to operate with a diversity and multiplicity of AC and DC offsite, onsite, emergency, and nonemergency power sources which exceeds all of the requirements stipulated by SRP Subsection 9.5.3. The design assures adequate lighting to all vital areas necessary for safe shutdown of the reactor, and to access routes to and from these areas.

9.5.4 Diesel Generator Fuel Oil Storage and Transfer System

9.5.4.1 Design Bases

The design of the diesel generator fuel oil storage and transfer system is based on the following requirements:

a. Provide a minimum of seven days supply of fuel oil onsite for each redundant diesel generator system, to meet the maximum Engineered Safety Feature load requirements following a loss of offsite power and a design basis accident.

b. Provide for an adequate source of fuel oil to recharge the fuel oil tanks. Provide cross-connect piping (separated by locked closed valves) between the fuel oil transfer pump suction and discharge so that each diesel generator can supply continuous uninterrupted emergency power.

c. The stored fuel is protected from degradation by deleterious material entering the system during recharging, by operator error, or due to natural phenomena. Periodic tests are performed to verify that engine performance is not affected by any possible fuel degradation.

d. A single failure of any active component of the diesel generator fuel oil storage and transfer system cannot affect the ability of the system to store and deliver the required fuel oil.

e. Sufficient space is provided to permit inspection, cleaning, maintenance and repair of the system.

f. The storage tanks, transfer pumps, day tanks, and associated piping are designed in accordance with the ASME B&PV Code Section III, Class 3, and seismic Category I requirements. All remaining equipment and piping as shown on Figure 9.5-9, and Figure 9.5-10 are in accordance with manufacturer's standards.

g. The system and the structures housing the system are designed to withstand the effects of natural phenomena, including the SSE, tornado, missiles, flooding, internally generated missiles, and forces associated with postulated pipe breaks.

The fuel oil storage tank, transfer pump and associated fill, drain and transfer piping are designed to ASME Section III, Safety Class 3 requirements, with seismic Category I supports.

The diesel generator engine fuel oil storage and transfer system design is in compliance with the requirements of ANSI Standard N195, except that (1) each tank is provided with a vent and flame arrestor designed to ANSI B31.1 requirements and (2) the storage tank fill lines do not include a strainer, since the fuel oil is normally filtered by the duplex strainers in the suctions to the fuel oil transfer pumps and also by the duplex strainers in the outlets of the day tanks to the diesel engine. Additionally, prior to reaching the engine fuel headers, the fuel oil is filtered by duplex filters (see Figure 9.5-9 and Figure 9.5-10).

9.5.4.2 Description

Each diesel generator has a completely independent fuel oil storage and transfer system consisting of a fuel oil storage tank, transfer pump, and interconnecting piping for supplying fuel oil to a day tank which, in turn, supplies fuel oil to the diesel engine skid. The flow diagram of the fuel oil system is shown in Figure 9.5-9 and Figure 9.5-10.

The fuel oil storage and transfer system components are located in the lower level of the Diesel Generator Building at Elevation (-)16-0" (see Figure 1.2-34, Figure 1.2-35, and Figure 1.2-36). The building is designed to withstand an SSE, tornados, external missiles and flooding.

Each DG fuel oil storage tank room is provided with air vents, smoke relief vents and room relief vents. The air and room relief vents provide air circulation for ventilation of these rooms. The smoke relief vents provide an escape for smoke in the event of a fire in the storage tank rooms. The smoke from a fire in one storage tank room may affect the operation of the diesel generator it serves, but will not affect the other diesel generator. The storage tank room vents are terminated 5 feet above grade, at elevation 25'-0". The vents for the storage tanks are terminated 13 feet above grade, at elevation 33'-0". The DG skids are set on the DG room floor at elevation 21'-6". The probable maximum flood level is at elevation 20.6 feet.

Each diesel engine has one horizontal, cylindrical fuel oil storage tank, which is physically separated from the tank for the other diesel engine by a solid reinforced concrete wall with no openings. The fuel oil storage tank contains enough No. 2 diesel fuel oil to meet the maximum Engineered Safety Feature load requirements following a loss of offsite power and a design basis accident for a period of seven days. Fuel reserve for testing purposes is provided by the excess supply of fuel oil in the storage tanks and day tanks which can be replenished on an as-needed basis. Enough excess fuel is on hand in the storage tanks and day tanks for approximately seven hours of test operation at continuous rated load for each engine.

Each storage tank has transfer pump suction and drain connections on the bottom. The top of each tank has connections for a manway, overflow from the day tank and the engine, flame arrestor and pressure relief vent piped to the outside, a level gauge, and fill line connection (located to minimize the chance of damage). The tank vent point is piped higher than the probable maximum flood level. The truck fill connection, which is shared by both diesel generator sets, is located outside on the north wall of the Diesel Generator Building, with valves at each storage tank and on the common fill header for control purposes.

The components of the fuel oil system have protective coatings to minimize the possibility of fuel oil contamination. The fuel oil storage tanks are protected internally by a corrosion resistant coating, and externally by a shop-applied inorganic epoxy primer. All protective coatings have been applied in accordance with manufacturer's recommendations and standard industry practice.

The fill line runs from a truck connection near grade elevation outside on the north wall of the Diesel Generator Building, with a branch line to each storage tank. The truck connection is normally capped, and the branch line to each tank includes a normally closed valve. The vent lines from each storage tank are piped through the outside wall of the Diesel Generator Building and include a flame arrestor. These lines terminate 13'-0" feet above grade at elevation 33'-0", and are designed to prevent direct entry of rain, snow and debris. During adverse environmental conditions, the plant operators will verify that the vents are not affected by debris, ice, or drifted snow.

Fuel oil from the storage tank is transferred to the diesel generator day tank by the diesel generator fuel oil transfer pump, a motor-driven positive displacement pump located next to the storage tank. Pump suction is through a duplex strainer. The fuel oil level in the day tank controls the operation of the transfer pump.

To maintain a positive head on the engine-driven fuel pump or the auxiliary motor-driven pump, the fuel oil day tank is located on the upper floor of the Diesel Generator Building. The tank is totally enclosed in a separate room that can retain the tank's contents and is equipped with a floor drain. The tank is protected from over-pressure by a pressure relief vent with a flame arrestor. The connecting piping to the diesel generator is not routed near any ignition source such as an open flame or hot surface.

The fuel oil pumps, one engine-driven and the other motor-driven auxiliary are mounted on the diesel generator skid and supply fuel oil to the injector pumps. The injector pumps are cam-operated and feed the injectors, mounted in the heads for combustion. Engine high pressure fuel return is to the day tank, while the low pressure gravity drain is to the dirty fuel oil reservoir.

Each below-grade storage tank room can retain the contents of the tank in the event of a pipe or tank rupture. Each storage tank room and diesel generator room is provided with drainage trenches. A dividing wall separates each room from the adjacent room. The storage tank pump suction line passes through the wall with a locked closed valve on each side. A fuel oil or cooling water line break in one room cannot flood the adjacent room.

For a discussion on fire protection systems for the Diesel Generator Building, see Subsection 9.5.1.

For system equipment data and design details, see Table 9.5-4.

9.5.4.3 Safety Evaluation

The total capacity of each diesel generator's fuel oil system is sufficient to maintain operation of the diesel generator for 7 days to meet the maximum Engineered Safety Feature load requirements following a loss of offsite power and a design basis accident. Additional fuel oil can be delivered to the plant site by truck to replenish the fuel supply system following an accident, to enable each diesel generator system to supply uninterrupted power for as long as may be required.

If continuous operation of a diesel generator is required for an extended period of time, refilling of the storage tank during this time may cause sediment to be resuspended in the fuel oil and lead to engine failure. The following measures have been taken to minimize this possibility: the fill and transfer pump suction connections on the storage tanks are offset by 84", the suction connection extends 3" above the bottom of the tank, and the suction line includes a duplex strainer to remove any sediment drawn from the tank. Additionally, prior to refilling of the storage tanks, the fuel oil day tanks would be filled. These tanks provide approximately 1½ hours of operation at full load for each diesel generator before the tanks will automatically refill. This time frame will allow sediment to settle prior to refilling the day tanks. Under accident conditions, if tank level is less than 50 percent full, a 24-hour settling time will be provided on the tank being filled. During this time, the redundant DG can be operated, or fuel oil can be supplied from the other fuel oil storage tank through the interconnecting piping.

In the unlikely event that the truck fill connection is inaccessible due to rain, snow, ice, or flood conditions, the tanks can be filled through the tank relief lines by removing the relief valve, or through the spare 4" nozzle on the top of the tank.

Adequate means of snow or ice removal equipment are available should either the normal or alternate fill connections be blocked. Should a fill hose be required to be brought into the building, fire protection controls will be implemented in accordance with the Fire Protection Plan.

There is complete redundancy of components for the diesel generator's fuel oil system. An independent fuel supply system is provided for each diesel generator, with the exception of the common fill station outside on the north wall of the Diesel Generator Building. Interconnecting piping between the storage tank, transfer pump and day tank piping, which is normally closed off by double Class 3 valves, allows for the transfer of fuel oil to the adjacent engine's components. This pipe, as shown in Figure 9.5-9 and Figure 9.5-10, has a line identification number of 4374-04, and allows the direct transfer of fuel oil from one storage tank to the other without affecting either day tank or engine piping. It also allows the discharge of contaminated fuel oil from either storage tank through the truck connection.

During transfer of fuel oil from one storage tank to the other day tank, the normally closed storage tank fill valves (V102 and V103) will prevent diversion of fuel oil back to the storage tanks. A locked closed valve (V252) is included in the transfer interconnect line (4374-04) to provide isolation from the transfer line and the fill line.

All the motor-driven pumps are powered from the bus on which the diesel generator it serves is connected.

The fuel oil storage tank fill lines are designed to seismic Category I, ASME Section III, Class 3, requirements. The external vent lines are designed to ANSI B31.1 requirements, with Class 3 piping and seismic Category I supports inside the Diesel Generator Building. This design is considered adequate, since capability of refilling the tanks is assured, and alternate means of venting can be provided if necessary.

The portion of the vent lines inside the Diesel Generator Building is designed to seismic Category I, Class 3, requirements. The portion of the vent lines outside the Diesel Generator Building is not protected from damage by tornado missiles; damage to this piping is unlikely to affect operation of the diesel generators. In the unlikely event that the storage tank vent lines are damaged, temporary provisions for venting can be provided during refilling.

Should all fill and vent connections external to the building be damaged, filling can still be accomplished via the spare 4" connection inside the building, and venting could be accomplished by unbolting the manway cover. Fire protection controls, in accordance with the Fire Protection Plan, would be implemented under these conditions.

There are no high or moderate energy lines or nonseismic Category I items located close to the fuel oil system whose failure could affect the operation of the fuel oil systems of both diesels.

The results of a failure modes and effects analysis are given in Table 9.5-5.

9.5.4.4 Tests and Inspections

During the preoperational test program, the diesel generator fuel oil system is tested for integrity in accordance with the ASME Boiler and Pressure Vessel Code, Section III, Class 3 requirements. Preoperational tests are performed to verify proper system operation.

During plant operation, the diesel generator fuel oil system integrity and operability will be demonstrated during periodic tests of the diesel generator, as required by the Technical Specifications. The system will be inspected in accordance with ASME Code, Section XI requirements.

Tests of new fuel are performed per requirements stated in Regulatory Guide 1.137 except as follows:

- A clear and bright test per ASTM D4176-82 may be performed as an acceptable measure of the water and sediment test.
- An ASTM D2274-70 test for distillate fuel oil accelerated method is not performed.
- All ASTM D975 test results other than water and sediment, viscosity, flash point and API gravity are completed within 31 days instead of 2 weeks.
- The 10-year interval pressure test of the fuel oil system will be conducted in accordance with the inservice test program as specified in Technical Specification 4.0.5 in lieu of a 110% pressure test (authorized by License Amendment 54).

The monthly tests of the oil stored in the fuel storage tanks are

- Accumulated Water
- Total particulate per ASTM D2276-78

Required testing of both new and stored fuel oil is controlled by the diesel fuel oil testing program contained in Technical Requirements Manual, Program 5.1.

Fuel oil samples are tested on a periodic basis for algal and bacterial growth. If they are detected, a suitable microbiocide additive, such as Biojar J. F. or Vancide 51, may be used.

Every 10 years, or earlier if necessary, the fuel oil will be removed and the tank cleaned using a sodium hypochlorite solution or equivalent, as required by Regulatory Guide 1.137.

In addition, an exception is taken to the 10 year requirement to perform a pressure test of those portions of the diesel fuel oil system designed to Section III, subsection ND of the ASME Code at test pressure equal to 110% of the system design pressure, as required by Regulatory Guide 1.137.

9.5.4.5 Instrumentation

A safety-related level sensor at each day tank functions to operate the fuel oil transfer pump with separate level sensors at the tank, alarm low level in the control room as well as high and low levels at a local panel. The operator can run the transfer pump manually from the motor control center. This pump will automatically start on low tank level.

Level in the fuel oil storage tank is indicated in the control room. A separate sensor alarms on low tank level, indicating approach to Technical Specification and operational limits.

Pressure is monitored at the fuel inlet headers by PS-FPLA (see Figure 9.5-9 and Figure 9.5-10). Low pressure is alarmed locally and in the control room. With its control switch in the "auto" position and the diesel engine running normally, the electrically driven auxiliary fuel oil pump will start on this low pressure signal. The auxiliary fuel oil pump will continue to run until shutdown by the operator or when the engine stops.

The operator may run the auxiliary fuel oil pump by switching the locally mounted control switch to the "run" position. Excess high pressure fuel oil is returned to the fuel oil day tank.

Pressure of the fuel oil transfer pump is indicated at the inlet by PI-9595 and at the outlet by PI-9502. Should it become necessary, the fuel oil day tank may be filled from the other train's storage tank by operator action using locked closed valves and the other train's fuel oil transfer pump.

In "auto," the auxiliary fuel oil pump is interlocked with engine speed of over 375 rpm.

High differential pressure across the strainer in the fuel oil transfer line is alarmed locally, by PDIS-9540, and is an input to the common trouble alarm in the control room.

High differential pressure across the strainer in the inlet to the fuel oil pumps is alarmed locally, by PDS-FSHD, and is an input to the common trouble alarm in the control room.

High differential pressure across the fuel oil filters is alarmed locally, by PDS-FFHD, and is an input to the common trouble alarm in the control room.

Local alarms identify clogging filter, clogging strainer, and low fuel pump discharge pressure while the system is operating. A common engine trouble alarm in the control room indicates other problems in the fuel delivery system, such as high and low day tank level.

The schedule and scope of instrumentation calibration and testing will be in accordance with applicable requirements of the Technical Specification and other recommendations of the vendor's technical manuals.

Operator procedures for responding to each alarm signal are available.

9.5.5 Diesel Generator Cooling Water System

9.5.5.1 Design Bases

The design of the diesel generator cooling water system is based on the following requirements:

a. The functional performance of the Cooling Water System is not adversely affected by environmental occurrences, abnormal operation, accident conditions, and loss of offsite power.

b. Redundancy of components is provided so that a malfunction or single failure of a component will not reduce the safety-related functional performance capabilities of the system.

c. System components and piping have sufficient physical separation or shielding to protect the system from missiles and forces associated with pipe breaks.

d. System components have appropriate quality group and seismic design classification.

e. Structures housing the system and the system itself are designed to seismic Category I requirements and are capable of withstanding the effects of natural phenomena as specified in the General Design Criteria.

f. Portions of the system can be isolated in the event of excessive leakage or component malfunction.

g. Suitable corrosion inhibitor and antifreeze compound are used to preclude long-term corrosion and organic fouling that would degrade system performance.

h. The cooling system components have sufficient capacity to maintain manufacturer's recommended fluid temperature under adverse operating conditions.

i. The system includes appropriate provisions and instrumentation for functional testing to assure integrity, operability, and performance of the system components.

j. Electrical components, including protective interlocks, are provided to insure reliable operation of the system during emergency conditions.

k. Shared systems and components are capable of performing required safety functions.

l. Sufficient space is provided to permit inspection, cleaning, maintenance, and repair of the system.

9.5.5.2 Description

Each diesel generator has a completely independent closed-circuit cooling water system which circulates treated demineralized water to the diesel engine components requiring cooling water. The system consists of heat exchangers, engine-driven pumps, motor-driven pump, expansion tank and interconnecting piping for supplying water to the diesel engine skid. The flow diagram for the diesel generator cooling water system is shown in Figure 9.5-11.

The heat exchangers, expansion tanks, and interconnecting piping (except as defined by the diesel manufacturer), for the main cooling water system are designed in accordance with ASME B&PV Code, Section III, Class 3, and seismic Category I requirements. All remaining on-engine and on-skid equipment and piping are designed in accordance with manufacturer's standards. The auxiliary coolant pump motor, standby circulating pump motor and jacket coolant heaters are non-Class 1E and are powered from the associated emergency bus. See Table 9.5-6 for the system equipment data.

The cooling water system components and piping are housed in seismic Category I structures designed to withstand an SSE, tornadoes, external missiles and floods. There are drainage trenches around each DG skid to control flooding, so that failure of the cooling system of one DG cannot affect the other. The drain trenches in the storage tank rooms and the diesel generator rooms are not connected, so that a fuel line or cooling water line break in one room cannot flood another room. Also, each DG skid and the auxiliary skids are supported off the floor by the skid foundations (see Updated FSAR Figure 1.2-34, Figure 1.2-35 and Figure 1.2-36). All system components, except the heat exchanger, are located in the Diesel Generator Building (see Figure 1.2-35 and Figure 1.2-36); the heat exchanger is located in the Primary Auxiliary Building (see Figure 1.2-9).

The diesel generator cooling water lines exit the building below grade through the west wall and enter the Primary Auxiliary Building below grade. The underground portions of the cooling water lines are a minimum of seven feet below grade, to provide protection against freezing and tornado missiles.

The buried portions of these lines are physically separated from each other so that a moderate energy line break in one line will not affect the integrity of the others. There are other moderate energy lines adjacent to the buried diesel generator cooling water lines. The location and separation of these lines preclude any effect on the cooling water lines. In the unlikely event of a leak or break, all service water lines adjacent to and below the diesel generator lines can be isolated (see Figure 9.2-1 and Figure 9.2-2).

The cooling water piping for one diesel generator unit does not pass through any areas associated with the other unit. The piping exits to the yard through the west wall of the storage tank rooms, which are separated by a division wall. There are no high energy lines in either building whose failure could affect the cooling water piping. Adequate drainage is provided in these buildings to prevent flooding caused by a crack in the cooling water piping, or other adjacent moderate energy piping.

The buried piping has been coated and wrapped prior to installation with Tapecoat-20, applied in accordance with the manufacturer's recommendations and standard industry practice. An impressed current system for cathodic protection has also been provided.

When the diesel generator is operating, removal of heat from the cooling water is accomplished by circulating cooling water through the shell side of the main heat exchanger which is located in the Primary Auxiliary Building, with service water (sea water) circulating through the tubes.

The heat exchanger drain, vent, and relief valve discharge lines are connected to the floor and equipment drains downstream of normally closed valves. The lines are normally empty, and are connected to the floor and equipment drain system as a convenience to avoid puddles on the floor during system maintenance and startup operations. During normal plant operation, the valves in these lines are closed to maintain cooling water system integrity. A failure of these lines will not affect operation of either diesel generator. There is no flood hazard in the PAB due to the size (1" and 3/4") of these lines.

The engine-driven jacket coolant pump discharges cooling water to the engine cylinder walls and turbo-charger prior to being returned through the main heat exchanger. For low coolant water temperature, the coolant water bypasses the main heat exchanger through a temperature-controlled bypass valve and is directed to the suction side of the jacket coolant pump.

The engine-driven air cooler pump discharges cooling water to the air cooler, generator bearing and the lube oil cooler prior to being returned through the main heat exchanger. The air cooler pump is piped in parallel with the jacket coolant pump.

The Cooling Water System will dissipate the heat transferred to the diesel generator jacket water, lube oil, and engine air coolers via the diesel generator heat exchanger.

The noncode (manufacturer's standard) motor-driven auxiliary coolant pump is located off-skid and is piped in parallel with both the jacket coolant pump and the air cooler pump with Class 3 piping and isolation valves. The auxiliary coolant pump starts automatically in the event of failure of either or both of the engine-driven pumps. The auxiliary coolant pump can also be started manually by the operator.

The valves connecting the auxiliary coolant pump to the coolant piping for jacket coolers and air coolers are pneumatic cylinder operated. The valves open automatically on low coolant pressure. For the jacket coolers, valves V11 and V12 are opened on low outlet coolant pressure. For the air coolers, valves V9 and V13 are opened on low coolant pressure. Ref. Dwg. 503486 (Updated FSAR Section 1.7). The supply air to the valve operators is controlled by solenoid valves which are activated by pressure switches. The air is supplied through a reducing valve connecting to the on-skid air start piping. A failure of these valves or air supply will not affect operation of the engine-driven pumps or the cooling capability of the system.

When the diesel generator is not operating, the engine block is maintained in a warmed condition to provide reliable starting. This is accomplished by maintaining the cooling water at a temperature recommended by the manufacturer. The cooling water is pumped through the jacket coolant heater and back into the jacket by the jacket coolant standby circulating pump. In the standby condition, the only portion of the Cooling Water System that requires operation is the circulating pump, heater, and associated piping to and from the engine jacket.

When the diesel generator is operating, the jacket coolant heater and jacket coolant standby circulating pump will stop operating. The three-way temperature control valves in the on-skid piping will automatically mix heated cooling water from the engine with cold cooling water from the heat exchangers and associated piping. The jacket coolant three-way temperature control valves are maintained in the maximum heat position during standby and engine startup to prevent the volume of keep warm coolant from mixing with cold water from the heat exchanger until required by engine heat load.

The cooling water temperature is controlled between 170°F and 180°F at the engine outlet. The control valves admit cold water when the engine outlet temperature reaches 170°F and thereafter admit sufficient cold water to maintain that setpoint. The engine is capable of operating for three minutes without any flow of service water to the heat exchanger.

A corrosion inhibitor and antifreeze compound is mixed with demineralized water in accordance with manufacturer's specifications. To maintain the proper quantity of water within the system, an expansion tank is located at the highest point in the Cooling Water System. The cooling water expansion tank has a design capacity of 290 gallons and is located 46 feet above the engine skid at elevation 67'-6". This location assures that the pump NPSH requirements are maintained. Pump shaft seals, valve stem packing and other components are checked for zero leakage during routine engine testing. The expansion tank capacity can allow a leak of 1.7 gph for seven days without loss of contents. The tank is replenished manually from the demineralized water system as required. The tank also has connections for overflow and drain lines, and for the addition of corrosion inhibiting chemicals.

The cooling water will be treated to ensure component corrosion is minimized. A compatible corrosion inhibitor will also be added to antifreeze used in the cooling water system. Freeze protection will be checked on a monthly basis. Coolant will be analyzed for corrosion inhibitor, corrosion products and contaminants. Adjustments to coolant chemistry will be made as recommended by the coolant supplier.

9.5.5.3 Safety Evaluation

There are two redundant diesel generators. Each diesel generator has its own independent cooling water system, with an independent source of water to the jacket cooling water heat exchanger. This redundancy and independence protects the diesel generators against any single failure. In addition, the motor-driven auxiliary coolant pump provides coolant water circulation in the event of failure of the on-skid pumps.

There are no high or moderate energy lines located close to the Cooling Water System whose failure could affect the operation of the diesel generator.

The results of a failure mode and effects analysis covering piping connections between the engine subsystems are as follows:

Component	Failure Mode	Effect on Diesel Generator
Jacket water cooler	Tube leak	Gradual dilution of cooling water by service water; relief valve protects cooling water system from overpressure. DG can continue operating.
Lube oil cooler	Tube leak	Gradual dilution of cooling water by lube oil; relief valve protects cooling water from overpressure; alarms provided for low lube oil level and pressure. DG can continue operating.
Engine air cooler	Tube leak	Gradual addition of cooling water to combustion air, causing visible steam in exhaust DG will gradually lose load capability. Redundant DG will start and maintain load.
Governor oil cooler	Tube leak	The governor oil operates at a higher pressure than the Cooling Water System. Loss of oil from the governor is visible in oil level sight glass. DG can continue operating.

9.5.5.4 Tests and Inspection

During the preoperational test program, the diesel generator cooling water system is tested for integrity as required by the ASME Boiler and Pressure Vessel Code, Section III. Preoperational tests are performed to verify proper system operation.

During plant operation, the cooling water system operability is verified during periodic tests of the diesel generators as required by the plant Technical Specifications. The system is inspected in accordance with ASME Code, Section XI requirements.

During the diesel generator's monthly operational test, the engine's cooling system is checked for evidence of tube leakage in the heat exchangers. The following leak conditions and detection means are available to determine leakage:

Condition	Means of Detection
Jacket water leakage into lube oil system (Standby mode)	1. Low level alarm on JW expansion tank 2. Lube oil tests
Lube oil leakage into jacket water (Operating mode)	1. Low level alarm on engine crankcase 2. Overflow of JW expansion tank 3. Jacket water sampling
Jacket water leakage into air intake (Operating-standby mode)	1. Low level alarm on JW expansion tank 2. Steam in engine exhaust
Jacket water leakage into governor oil	1. Oil level sight glass
Service water leakage into jacket water	1. Overflow of JW expansion tank 2. Jacket water sampling

Note that the above abnormal conditions would be detected before operational limits are exceeded, or engine performance is affected. Corrective measures will be employed as required.

The following equipment will also be tested periodically:

- Jacket coolant standby circulating pump and heater
- Auxiliary coolant pump.

The schedule and scope of instrumentation calibration and testing is in accordance with the applicable requirements of the Technical Specification and other recommendations of the vendor's technical manuals. Calibration frequencies will generally be on a refueling interval or as relative to the importance of the specific instrument.

9.5.5.5 Instrumentation

The jacket coolant standby circulating pump operates when the diesel generator is not in operation. It circulates the cooling water through the jacket coolant heater whenever the coolant temperature falls below the preset value. The engine block is maintained in a warmed condition at standby to facilitate engine starting.

The operation of the motor-driven auxiliary coolant pump is interlocked with the pressure of jacket cooler coolant pressure or intercooler coolant pressure, or both. Manual operation of this pump can be performed from the motor control center.

Jacket coolant effluent temperature is monitored by a temperature control loop consisting of temperature transmitter TT-7A1 with a pneumatic signal to derivative unit TYY-7A-1 and then to temperature controller TC-7A1 controlling temperature control valve TCV-7A1 which diverts the jacket coolant water through the diesel generator component cooling water heat exchanger E-42A or partially bypasses the heat exchanger.

High temperature in the jacket coolant effluent is alarmed in the control room and at the local panel by temperature switch TS-CTHA in the jacket coolant effluent line (see Figure 9.5-11). Upon receiving system alarms, the operators will take corrective action as required by the particular Alarm Response Procedure.

Diesel generator intercooler (air cooler) water temperature is monitored by a temperature control loop consisting of temperature transmitter TT-7A2 and temperature controller TC-7A2 controlling temperature control valve TCV-7A2 which regulates the amount of water that goes through the heat exchanger or is recirculated.

The effluent from the intercooler (engine air cooler) is divided, some water circulated through temperature control valve TCV-7A2 to the Air Cooler System and some bypassed through the lube oil heat exchanger E-41A. The air cooler outlet flows through the lube oil heat exchanger to the diesel generator component coolant heat exchanger E-42A.

Jacket coolant inlet pressure is monitored by pressure switch PS-CPS whose setpoint is adjusted to correspond to an engine speed of 375 rpm and whose contact forms a part of the "Alarm Permit" logic.

Low air cooler inlet water pressure is detected by pressure switch PS-IPLA which provides a local alarm and an input to the DG system trouble alarm at the computer. This pressure switch also opens the auxiliary coolant valves V9 and V13 and starts the auxiliary coolant pump. After the diesel generator is shutdown, the auxiliary coolant pump is stopped and the valves closed by operating the local control switch to off.

The inlet pressure of the jacket coolant system is also monitored by pressure switch PS-CPLA. Should the jacket coolant inlet pressure drop below setpoint pressure the auxiliary coolant valves V11 and V12 are opened and the auxiliary coolant pump started to provide water to the jacket coolant system.

The auxiliary coolant pump runs if either or both the air cooler or jacket water coolant systems require additional pressure.

Low level in the expansion tank is alarmed locally by level switch LS-CLLA. This switch also is an input to the DG system trouble alarm at the computer. Local indication is provided by a level gage. The expansion tank level may be increased by the operator manually valving demineralized water into the tank.

In conformance with ICSB-17, all diesel generator coolant system protective interlocks affecting diesel operation are bypassed on an accident signal by a lockout relay. The alarms are not inhibited, and the bypass circuitry is testable. Protective trips are interlocked in such a way that they could not interfere with the successful functioning of the diesel generator during an accident condition.

9.5.6 Diesel Generator Starting Air System

9.5.6.1 Design Bases

a. The diesel generator starting air system is capable of starting a diesel engine following a design basis accident, while assuming a concurrent single active failure and loss of offsite power.

b. Each diesel engine is provided with an independent and redundant starting air system, with each system consisting of a compressor and two air receivers mounted on a common skid, piping to the engine skid, with valves and devices to crank the engine. The compressor capacity is adequate with respect to receiver capacity of the redundant starting air system.

c. Without recharging the air receiver, each starting air system is capable of starting a diesel generator within 10 seconds at least five times.

d. Alarms are provided to alert the operating personnel if the air receiver pressure falls below the minimum allowable value.

e. Provisions are incorporated for periodic blowdown of accumulated moisture and foreign material in the air receivers.

f. The air receiver, valves and piping to the engine are designed in accordance with the ASME Code, Section III, Class 3 and seismic Category I requirements. The remaining components and piping as shown on Figure 9.5-12 are designed to manufacturer's standards.

g. The systems are protected from extreme natural phenomena, such as the safe shutdown earthquake, the probable maximum flood, hurricanes, and tornado missiles.

h. The systems are located to avoid the effects of pipe whip or jet impingement resulting from high and moderate energy pipe breaks.

i. The diesel generator starting air system is capable of supplying sufficient makeup control air to support long-term engine operation.

j. Each diesel engine has an available backup control air compressor that can be aligned to the receivers in the event that the starting air compressor is not available to provide control air. The unit is capable of supplying sufficient control air to support long-term engine operation.

9.5.6.2 Description

Each of the diesel generators has an independent starting air system capable of starting the diesel engine within ten seconds and an independent control air system. The diesel generator starting air system is shown in Figure 9.5-12. Part of the system is mounted on the diesel engine skid and part on the starting air skid, with interconnecting piping. Additional details are provided in F.P. 20591.

The engine is designed for a 435 psig, air-over piston starting system with separate solenoid valve and starting air distributor for each bank of cylinders. On initiation of a start signal, starting air is applied through redundant components to both banks of cylinders simultaneously to accelerate the engine to provide rated frequency and voltage in less than 10 seconds.

Each redundant portion of the starting system has an independent receiver, supply line, air start valve and distributor, and supplies starting air to half of the engine cylinders (one bank). If either portion of the starting system should fail, the other portion, already activated, will continue to apply starting air to the engine.

Starting air is supplied by the starting air compressor assembly which includes a starting air compressor and two receivers, all mounted on a common skid. The starting air system has a minimum capacity for five starts in less than 10 seconds (see Subsection 9.5.6.3). The compressors are driven by motors powered from the associated emergency bus. Control and instrument air to the engine is also supplied by the compressor/receiver assembly.

Each starting air compressor is the auto start-stop type and is controlled by a pressure sensor on the air receivers. The starting air compressor is rated at 31 cfm and is sized to restore the receiver pressure between starts and provide a continuous supply of control air to support engine operation. The controls are set so that the compressor runs as required to maintain pressure on the air receivers. The compressor is equipped with a filter on the intake and a pressure relief valve on the discharge piping.

The air discharging from the compressor passes through a pulsation dampener, moisture trap, air dryer, dryer prefilter, dryer after filter, and check and stop valves before entering the receivers. Normally, both receivers will be fully loaded to provide a continuous supply of air. Pressure relief and blowdown valves are included on both receivers.

The air discharging from the receivers enters the starting air headers. The receivers also provide instrument air at 100 psi and 20 psi to other engine system components through pressure reducing valves. These components include the auxiliary cooling water pump solenoid valves and cooling water temperature control valves. The continuous air usage of these components is small and a sufficient supply is provided by the air compressors to ensure proper functioning of these components.

The air receivers, valves and piping to the engine are designed in accordance with ASME Code, Section III, Class 3. The air compressors, dryers, and non-ASME control air supply piping and valves are designed in accordance with manufacturers' standards and are classified ANS Safety Class 3. In addition, the component and piping design is based on seismic, vibratory and thermal loads. All starting air system components are located in the Diesel Generator Building, a seismic Category I structure.

Following a low pressure receiver indication and determination that the starting air compressor is not available, the backup control air compressor can be administratively aligned to the receivers. This unit is comprised of a compressor, cooler, moisture trap, filter, dryer and will supply sufficient air (10 scfm) to the receivers to support long-term operation of the engine. Switches on the receivers are set to cycle the compressor to maintain a minimum of 80 psig.

Equipment Data for the Starting Air System

1.	Air Compressors	One per DG set
	Manufacturer	Ingersoll-Rand
	Design Capacity	31 cfm @ 600 psig
	Drive	Electric Motor
	Motor, hp	15
	Source of Power	EDE-MCC-511 (A) EDE-MCC-611 (B)
	Voltage	460
	Phase/Frequency	3/60
	Manufacturer	Westinghouse
2.	Air Receivers	Two per DG set
	Manufacturer	Colt Industries
	Size	42.5" O.D. x 84"
	Design Pressure	700 psig
3.	Backup Control Air Compressor	One per DG set
	Manufacturer	Quincy
	Design Capacity	10 SCFM
	Motor hp	5
	Source of Power	EDE-MCC-511(A) & 611(B)
	Voltage	230/460
	Phase/Frequency	3/60
	Manufacturer	Baldor Electric Co.

The starting air system components include design margins for safety. The starting air compressor has a design capacity rating of 700 psig, but the compressor is controlled to unload and stop on increasing pressure at 600 psig. Each air receiver has a design pressure of 700 psig, but the relief valve is set at 630 psig.

9.5.6.3 Safety Evaluation

There are two redundant diesel generators. Each diesel generator has an independent starting and control air system consisting of a compressor, air receivers and associated piping. Further starting air redundancy is provided by the two independent starting air headers, one serving each cylinder bank. The engine will start when air is applied to either or both banks of cylinders. Control air is provided by one starting air header and the capability of cross-connecting headers is provided:

With both receivers supplying their respective banks, there is sufficient capacity for 5 starts in less than 10 seconds. If the engine fails to start within 9 seconds of receiving a start signal, the start will be aborted. Interlocks are provided so that a second automatic start will not occur. If necessary, the operator must initiate a manual start after clearing the fault which caused termination of the first start. In this case, it is assumed that the redundant DG will have started and accepted the design load.

An engine-mounted air cylinder is provided to drive the fuel rack to the off position for engine shutdown if air pressure is lost in both headers. Air supply to this cylinder is controlled by a 3-way, normally closed solenoid valve. The air tank upstream of this valve provides a reserve air supply for this function. The air tank is 6" diameter x 12" long, and is designed to 630 psig, in accordance with ASME Section III, Class 3 requirements.

The solenoid valve is energized to shutdown the diesel generator in case of a single failure. During an accident, this solenoid could be energized only by the emergency overspeed trip, the generator differential trip, manual action, or the 2 out of 3 engine low lube oil pressure trip. All other diesel engine trips are bypassed during an accident.

The redundant air start headers to each diesel generator are the only high energy lines in each diesel generator bay. The 2" lines from the air receivers (TK-45) to the main air start valves (V60, V224), the 3/8" lines to the air start solenoid valves (V43, V44), and the branch lines to valves V52 and V58, including the air tanks, are normally pressurized at 600 psig. These high energy lines are located and supported so that a loss, failure or pipe break of one line will not affect lines and equipment associated with the other diesel. All piping to the diesel generator is designed to seismic Category I requirements.

Since the diesel generator, along with its associated equipment and piping, operates independently and is physically separated by a solid reinforced wall, the redundant diesel generator will be available for service in the event of a high energy line break.

A loss of air pressure in one of the two redundant supply lines to the engine could affect the supply of control air to pneumatically operated cooling water control valves. With the control valves in the full open (maximum cooling) position, potential engine damage could occur due to overcooling. A backup control air compressor is available to supply sufficient air to support continued long-term operation of the engine. Following manual alignment of the unit, the system will auto control to maintain the receivers at control air pressure requirements.

A small air tank, isolated by a check valve, assures stopping capability if air pressure is lost in both headers. This redundancy and independence protects the diesel generators against a single failure.

There are no high or moderate energy lines or nonseismic items located close to the starting air system whose failure could offset the operation of the starting air system. Electrical components of the starting air system are enclosed and protected from potential water sprays.

The diesel generators will start and operate following a loss of offsite power. The safety function of the starting air system is not affected by a loss of offsite power.

9.5.6.4 Tests and Inspections

During the preoperational test program, the diesel generator air starting system will be tested for integrity in accordance with the requirements of the ASME Boiler & Pressure Vessel Code, Section III, and preoperational tests will be conducted to demonstrate system operability, control, and alarm functions.

During plant operation, the diesel generator starting air system operability will be demonstrated during periodic testing of the diesel generator. The starting air and backup control air compressor may be test-started locally at the motor control center.

The schedule and scope of instrumentation calibration and testing is in accordance with applicable requirements of the Technical Specification and other recommendations of the vendor's technical manuals.

Calibration frequencies will generally be on a refueling interval or as relative to the importance of the specific instrument.

Upon receiving system alarms, the operators will take corrective action as required by the particular alarm response procedure.

9.5.6.5 Instrumentation

Each air receiver is provided with pressure instrumentation for indicating, monitoring and controlling the starting air system. Air receiver pressures are maintained within the pre-set limits by auto start-stop operation of the starting air compressor by means of pressure switches. The starting air compressor control switch is normally locked in the "Auto" position. A manual test start of the air compressors is possible from the MCC.

With the starting compressor running, lube oil level is monitored by level switch LSL-9519A. See Figure 9.5-12. Low level is an input to the diesel generator system trouble alarm at the computer and is alarmed locally. Air temperature is monitored at the starting compressor outlet by temperature switch TSH-9529A. High temperature is alarmed locally and is an input to the diesel generator system trouble alarm at the computer. This alarm is actuated at 490°F increasing and drops out at 460°F decreasing.

Air pressure in the receiver tanks is monitored by pressure switches PS-APC1 and PS-APC2. These switches are adjusted to close at 560 psi decreasing, to start the compressor, and open at 600 psi increasing, to stop the starting air compressor. The receiver tanks are equipped with safety valves set at 630 psi.

With the starting air compressors out of service, diesel engine operation may continue with the standby air compressor providing the supply of instrument control air. Pressure switches PS-APC3 and PS-APC4 monitor pressure in the air receivers. These switches are adjusted such that their contacts close at 80 psig decreasing to start the standby air compressor, and open at 100 psig increasing to stop the standby air compressor. This will maintain a sufficient supply of control air in the air receivers should the starting air compressor be out of service. Upon determining that the starting air compressors are no longer in service, operator action will be taken to place the standby air compressor into service. It will operate automatically with the control switch locked in the auto position. A manual test start of the standby air compressor is available from the MCC.

To permit diesel air start, the barring devices, BD1 and BD2, must be disengaged. Air should then be available for starting when air start solenoid valves AS1 and AS2 are energized. The shutdown air receiver tank is charged and will shut the engine down by terminating the fuel oil supply to the engine should the shutdown solenoid, SDS, be energized.

Low starting air pressure is alarmed locally and at the computer as a system alarm by pressure switches PS-APL-1 and PS-APL-2.

Low-low starting air pressure in either air receiver tank in conjunction with no starting signal from either start circuit will energize the "DIESEL NOT AVAILABLE" monitor lights at the MCB, also at the local panel and activate a system alarm at the computer by pressure switches PS-APLL-1 and PS-APLL-2.

Low-low starting air pressure is alarmed locally and at the computer by pressure switches PS-APLL1 and PS-APLL2.

9.5.7 Diesel Generator Lubrication System

9.5.7.1 Design Bases

The diesel generator lubrication system provides essential lubrication to the components of the diesel engines, and removes heat due to friction from the engine. The system design is based on the following requirements:

a. Each diesel engine is provided with an independent lubrication system.

b. Components of the system are located in a seismic Category I structure and are thereby protected from adverse natural phenomena and external missiles.

c. The malfunction or failure of a component will not result in the loss of function of more than one diesel generator.

d. The system components are located to avoid the effects of pipe whip or jet impingement forces resulting from high or moderate energy pipe breaks.

e. The system is capable of maintaining continuous operation of the diesel engine without degradation of engine function.

f. All off-engine on-skid piping, heat exchanger and strainer for the main lubrication system are designed in accordance with ASME Code Section III Class 3, and seismic Category I requirements. All remaining equipment and piping, such as the auxiliary lube oil pump, and the rocker arm and prelube subsystems are designed in accordance with manufacturer's standards, as shown on Figure 9.5-13.

9.5.7.2 Description

Each diesel generator has an independent lubrication system, which is physically separated from the other diesel's system. The components of the lubrication system were designed and furnished by the engine manufacturer in accordance with engine requirements. The lube oil flows in a closed loop through a strainer, pump, cooler, to the engine components, and is returned to a wet sump. The sump is an integral part of the engine, and is the storage sink for the system. The sump is connected to an on-skid exhauster for the continuous removal of vapors to minimize the danger of crankcase explosions.

Connections are provided to monitor the quantity and quality of the lube oil in the sump. If necessary, the operator can add oil while the engine is running or shut the unit down to replace oil. Makeup is stored onsite and is added through a gravity fill connection. The fill connection is capped during normal operations. The lube oil is periodically replaced to prevent excessive engine wear due to dirty oil. Replacement oil will be obtained from offsite suppliers. The flow diagram of the lubrication system is shown in Figure 9.5-13.

The system components are located on the main level of the Diesel Generator Building, a seismic Category I structure (see Figure 1.2-34, Figure 1.2-35, and Figure 1.2-36). See Table 9.5-7 for the system equipment data and design details.

When the diesel engine starts, the lube oil is pumped through the system by the engine-driven lube oil pump. The pump is equipped with an integral pressure relief valve, a suction strainer and a check valve on the discharge piping. The oil discharged by the pump is piped to a three-way temperature-controlled valve. If the temperature of the lube oil is above the recommended temperature, the valve will position so that the lube oil flows through the lube oil cooler. The lube oil discharging from the cooler passes through a 30-micron strainer and then back into the engine. If the temperature of the lube oil is below the recommended temperature, the valve will position so that the lube oil bypasses the cooler and passes directly through the strainer.

The lube oil cooler is a conventional shell-tube type heat exchanger in which the oil circulates through the shell side and cooling water flows through the tubes. The cooling water to the cooler is part of the closed circuit cooling water system (see Subsection 9.5.5).

A noncode (manufacturer's standard) motor-driven auxiliary lube oil pump, located off the engine skid, is piped in parallel to the engine-driven lube oil pump, with Class 3 piping and isolation valves. The auxiliary pump will operate following a low oil pressure signal. The pump motor is non-Class 1E, and is powered from the associated emergency bus.

The rocker lube system is separate from the engine lube system described above. Lube oil to the diesel engine rocker arm is provided by the engine-driven rocker arm lube pump P-228 or the motor-driven rocker arm prelube pump P-227. Suction for both pumps is from the oil reservoir, with the pumps discharging through a 3-5 micron duplex filter to the engine rocker arms.

The engine-driven pump operates continuously when the diesel engine is operating. Upon engine test, the motor-operated rocker arm prelube pump is activated for approximately 5 minutes prior to the diesel engine start. The engine manufacturer recommends that the rocker arm prelube pump be operated once a week for 5 to 30 minutes. Plant operating procedures include this requirement. Actual emergency conditions do not require starting of the rocker arm prelube pumps.

When the diesel generator is not operating, the motor-driven engine prelube and filter pump P-116 operates continuously, drawing oil from the sump through a suction strainer and discharging the oil through an electric heater and a 5-micron filter and into the engine lubrication system downstream of the three-way temperature control valve. From this point the oil follows the same path as the main engine lube oil system. This assures continuous prelubricating of the engine and standby heating of the lube oil. Dangerous accumulations of lube oil that could lead to a fire are unlikely to occur while the engine is in standby mode because the lube oil is continuously drained by gravity back to the crankcase. The inspection covers for the crankcase are provided with spring safety valves for relief of internal pressure. The prelube and filter pump can be manually shutdown when the diesel generator is operating. The prelube and filter pump is also used for draining the engine sump. The prelube and filter pump motor and lube oil heater are non-Class 1E and are powered from the associated emergency bus.

9.5.7.3 Safety Evaluation

There are two redundant diesel generators. Each diesel generator has an independent closed-loop lubrication system, with an integral sump to store and supply lube oil. This redundancy and independence protects the diesel generators against any single failure in the lube oil systems.

In the event of component failure or excessive leakage in the system, isolation valves are provided.

There are no high or moderate energy lines located close to the lube oil system whose failure could affect the operation of the diesel generator.

The system does not include flow control devices or electrical interlocks subject to failure which would affect engine operation during emergency conditions. The safety function of the system is not affected by a loss of offsite power.

See Subsection 9.5.1 for details of conformance to Branch Technical Position ASB 9.5-1, as related to lube oil system fire protection.

9.5.7.4 Tests and Inspections

During the preoperational test program, the diesel generator lubricating system is tested to verify proper system operation.

During plant operation, the system operability is verified during periodic tests of the diesel generators, as required by the station Technical Specifications.

Lube oil quality and crankcase oil level are checked as part of the regular diesel generator testing, with addition or replacement as required. Station procedures assure the cleanliness of equipment used for oil addition and oil quality.

The auxiliary lube oil pump, P-117 may be test run by positioning the control switch, mounted at the motor control center, to "Run". This switch is normally key-locked in the "auto" position.

The schedule and scope of instrumentation calibration and testing is in accordance with applicable requirements of the Technical Specification and other recommendations of the vendor's technical manuals. Calibration frequencies will generally be on a refueling interval or as relative to the importance of the specific instrument.

Upon receiving system alarms, the operators will take corrective action as required by the particular Alarm Response Procedure.

9.5.7.5 Instrumentation

The motor-driven prelube and filter pump is designed to run continuously. When the pump is running, lube oil temperature is monitored by temperature switch TS-OHT (see Figure 9.5-13). The lube oil temperature is maintained at a temperature recommended by the manufacturer. This assures prelubrication of the engine with warm lube oil.

When the diesel generator is running, lube oil is pumped through a water cooled heat exchanger E-41. Temperature control valve, V29, determines the volume of oil that is directed through the heat exchanger. The remainder is bypassed back to the engine header. Lube oil temperature is monitored at the lube oil pump outlet header and high lube oil temperature is alarmed locally and at the computer. High lube oil temperature is also an input to the engine trouble shutdown logic.

Normally, when the diesel generator is in operation, lube oil is pumped by the engine-driven pump. Lube oil pressure is monitored by four pressure switches PS-OPL1, PS-OPL2, PS-OPL3, and PS-OPL4. PS-OPL1 will close at 70 psi decreasing, and reset at 75 psi increasing. PS-OPL2 will close at 65 psi decreasing and reset at 70 psi increasing; PS-OPL3 and PS-OPL4 will close at 60 psi decreasing and reset at 65 psi increasing.

With diesel generator running at greater than 375 rpm and the alarm permit logic satisfied, PS-OPL1 or PS-OPL2 will start the auxiliary lube oil pump. "Auxiliary Lube Oil Pump Running" is alarmed at this local control panel and at the computer. If the alarm permit logic is satisfied, the detection of low pressure by any one of the four pressure switches will be alarmed locally and at the computer. Two out of three low pressure signals from PS-OPL2, PS-OPL3, and PS-OPL4 will result in an engine trouble shutdown.

High level in the rocker arm lube oil reservoir is alarmed locally by LS-KLHA and is an input to the DG system trouble alarm at the computer.

Low pressure at the discharge of the rocker arm lube oil filter is alarmed locally by PS-KPLA and on the computer, provided the engine speed is greater than 375 rpm.

Level in the engine sump is monitored by level switch LS-OLLA, and low level is alarmed locally and at the computer. A pressure switch is provided to alarm a loss of vacuum.

Lube oil temperature in the engine sump is monitored by temperature switch TS-OTLA. Low temperature is alarmed locally and at the computer.

Differential pressure across the lube oil strainer is monitored by pressure differential switch PDS-OSHD. High differential pressure is alarmed locally and is an input to the DG system trouble alarm at the computer.

Lube oil high temperature and low lube oil pressure trips are provided. In accordance with BTP ICSB-17, the lube oil high temperature trip is bypassed under accident conditions. The lube oil low pressure trip is not bypassed under accident conditions because the required coincident logic is provided in the low lube oil trip circuit.

9.5.8 Diesel Generator Combustion Air Intake and Exhaust System

9.5.8.1 Design Basis

The diesel generator combustion air intake and exhaust system is capable of supplying adequate combustion air and disposing of resultant exhaust products to permit continuous operation of the diesel engine.

The system design is based on the following requirements:

a. Each diesel engine is provided with an independent air intake and exhaust system.

b. Components of the system are located in a seismic Category I structure which provides protection from external missiles, natural phenomena, and contaminating substances.

c. The consequences of a single active failure in the system will not result in the loss of function of more than one diesel generator.

d. The system components are located to avoid the effects of pipe whip or jet impingement forces resulting from high and moderate energy pipe breaks.

e. The system is capable of maintaining operation of the diesel engine at maximum rated power output without degradation of engine function.

f. The system piping is designed in accordance with ANSI B31.1, Power Piping. Component and piping supports are designed in accordance with seismic Category I requirements.

9.5.8.2 Description

The diesel generator combustion air intake and exhaust system consists of an intake filter, plenum, exhaust silencer, and interconnecting piping, as shown in Figure 9.5-14. The system is located in the upper levels of the Diesel Generator Building, a seismic Category I structure (see Figure 1.2-34, Figure 1.2-35, and Figure 1.2-36).

The DG air intake filters and exhaust silencers are not commercially available as ASME Section III, Class 3 design. All off-engine piping in the intake, exhaust and crankcase vacuum systems is designed to seismic Category I requirements, and conforms to Quality Group D requirements of Regulatory Guide 1.26. The filters, silencers, bellows and on-engine exhaust manifold piping are designed to manufacturers' standards. Component supports and piping supports are designed in accordance with seismic Category I requirements.

The exhaust manifold piping and bellows are required for continuous operation of the engine at its rated capacity. Accordingly, these parts are classified as safety-related items.

The intake air is filtered by a dry-type air intake filter, passes through the intake plenum, and is piped to the diesel generator turbochargers. The intake filters reduce the airborne particulate matter in the combustion air during engine operation. The combustion air is compressed by the turbochargers and delivered to the cylinder heads by the inlet manifold.

The exhaust gases are manifolded through the turbochargers and exhausted to atmosphere through an exhaust silencer. The point of discharge is physically separated from the intake point to preclude degradation of engine function due to dilution of the intake air by exhaust gases.

The air intake and exhaust piping is designed for shop fabrication of spool assemblies to minimize the field installation effort required. Flanged joints are used to facilitate fit-up, and reduce the number of field-welded joints. The air intake lines have only one field weld, and the exhaust lines have only two field welds. The flanged joints in the exhaust piping will be visually inspected for leakage during periodic diesel generator testing.

Each engine is equipped with a crankcase exhauster to provide positive crankcase ventilation. The exhauster discharge is piped to a discharge point outside of the Diesel Generator Building. The crankcase exhauster is not safety-related and is not required for operation of the engine. Failure of the exhauster does not affect the starting capability of the engine.

The diesel engine exhaust stack has a drip leg, a 12" nominal diameter pipe approximately 2'-9" long, to capture precipitation. This leg is located in the horizontal piping between the vertical exhaust stack and the exhaust silencer. A deflector plate will be mounted on the exhaust stack to minimize the amount of precipitation that could enter and accumulate in the exhaust stack. Gate valves located at the bottom of the drip leg and also in the bottom of the exhaust silencer will be periodically opened to drain the exhaust system. Also, the high exhaust temperatures of 900°F-1000°F will quickly evaporate any captured precipitation when diesel engine is running.

The portion of the exhaust stack above the roof is not protected against tornado missiles. The stack extends only 2 feet above the level of the roof. It is further protected by a 60" outside diameter surrounding guide stack which extends 4 feet above the roof. This low effective target area results in a low mean value probability, calculated as less than 10^{-6}, for missile impact.

Each diesel-generator unit is capable of operating at its maximum rated output under the following outdoor service conditions and for the durations indicated during the following weather disturbances:

a. Outdoor Service Conditions:

1. Ambient air intake: -20 to 104°F

2. Humidity: 20 to 80% (in D.G. room)

   20 to 100% (outdoors)

b. Weather disturbances:

1. A tornado pressure transient causing an atmospheric pressure reduction of 3 psi in 3 seconds followed by a rise to normal pressure in 3 seconds. A shorter transient (1.5 seconds) will not affect engine operation and output.

2. A hurricane or northeastern storm pressure of 26 inches Hg for a duration of one (1) hour. The engine is capable of continued operation for up to 14 hours at 26" Hg with no effect on operation and output, since the combustion air system is designed for approximately 50 percent excess air.

A low ambient air intake temperature will have no effect on engine operation under load and output. Combustion air is preheated in the turbocharger and is supplied to the engine at a temperature of 100°F minimum and 200°F maximum. The diesel engine manufacturer has advised that an air temperature of -20°F or greater at the turbocharger inlet will result in sufficient engine air temperature preheating in the turbocharger to allow continuous no-load operation. Additional ambient air preheating will not be required.

Operation of the diesel generator at 50 percent or greater load for one hour after each 24 hours of running at no-load will maintain the engine in the standby condition, ready to accept load as required.

9.5.8.3 Safety Evaluation

There are two redundant diesel generators. Each redundant diesel engine has an independent combustion air intake and exhaust system. This redundancy and independence prevents the loss of function of more than one diesel engine in the event of a component or system failure.

The air intake and exhaust systems of each diesel engine are isolated from those of the other diesel engine and are also isolated from any motor-driven equipment by partition walls. Should an exhaust system leak develop, it would have no effect on the redundant diesel engine. The air intakes and room vents for diesel generator A are along the north wall of the Diesel Generator Building, over 80 feet from the air intakes and room vents for diesel generator B, which are along the south wall of the Diesel Generator Building (see Updated FSAR Figure 1.2-35).

The ventilation equipment room serves the control room and both diesel generators. This room is physically separated by a division wall. Also, the diesel generator intake and exhaust equipment room for each unit are physically separated by a division wall and the fuel oil day tank enclosures. These division walls have a three-hour fire rating. Therefore, a fire in one of these rooms will not affect equipment in the other rooms, nor affect operation of more than one diesel generator, even with a failure in the fire protection system. Fire dampers associated with the diesel generator room fans will protect the ventilation equipment in the event of a fire.

There are receivers and accumulators in the ventilation equipment room associated with the refrigerant for Control Building HVAC System. This refrigerant is R-22, an inert, nonflammable coolant.

There is no equipment in the DG equipment rooms at elevation 51'-6" that could generate an internal missile which would affect operation of either diesel generator.

The air intake and exhaust systems of each diesel engine are isolated from those of the other diesel engine and are also isolated from any motor-driven equipment by partition walls. Should an incident occur, such as an exhaust leak or an accidental discharge of a CO_2 extinguisher, it would have no effect on the redundant diesel engine.

The physical location of the air intakes makes the possibility of use of a CO_2 extinguisher in the area of the air intakes remote. However, should such extinguishers be discharged in the immediate area of the air intake, there would be no significant effect on engine operation. Based on tests from a diesel manufacturer, a CO_2 extinguisher discharging at the air intake for a period of over 30 seconds will dilute the air intake by less than one (1) percent. All diesel engines run at 50 percent excess air, which also helps in minimizing any effect of such an incident.

The fire protection equipment located in the diesel generator rooms, the diesel generator fuel oil day tank rooms and the diesel generator fuel oil storage rooms all consist of dry-piped, closed heat deluge systems. The piping is all seismically supported. Additionally, the deluge valves for all these areas are seismically qualified to prevent inadvertent actuation, and will remain functional both during and following a seismic event.

In the event of exhaust gas leakage in the immediate area of the air intake, the first evidence of exhaust recirculation will be increasing air intake temperature. The turbocharger and after-cooler will handle an exhaust quantity that could reasonably be defined as leakage, with no significant effect on engine operation.

Controls are interlocked in such a way that they could not interfere with the successful functioning of the diesel generator during an accident.

There are no high or moderate energy lines or nonseismic items located close to the Air Intake and Exhaust System whose failure could affect the operation of the Air Intake and Exhaust System.

There are no compressed gasses stored in sufficient quantities close enough to the air intakes to have a significant effect on DG operation.

The results of a failure mode and effects analysis are presented in Table 9.5-8.

9.5.8.4 Tests and Inspections

The diesel generator combustion air intake and exhaust system operability is demonstrated during preoperational and periodic tests of the diesel generator. The diesel crankcase exhauster (oil separator and vacuum pump) may be test run locally by switching its switch to "Run." This switch is normally key-locked in the "Auto" position.

During the monthly periodic or operational verification testing of the diesel, and following an extended (greater than 24 hours) operation of the diesel, the flanged joints and bellows on the diesel exhaust system will be visually inspected for leakage.

The schedule and scope of instrumentation calibration and testing is in accordance with applicable requirements of the Technical Specification and other recommendations of the vendor's technical manuals.

Calibration frequencies will generally be on a refueling interval or as relative to the importance of the specific instrument.

Upon receiving system alarms, the operators will take corrective action as required by the particular alarm response procedure.

Following the first five years of operation, but prior to ten years of operation, an inspection program, using appropriate techniques (i.e., visual, UT, RT, or other form of NDE), will be performed. This program will verify that the observed loss of wall thickness will not occur within the 40-year design lifetime of the system. Subsequent inspections, if required, will be scheduled based on the results of the first inspection and the predicted continued loss of wall thickness. Because of the identical use of components and operating conditions, the inspection program only needs to be performed on the EDG Exhaust System and will initially be limited to only the area of highest potential corrosion and erosion. This area is considered to be the exhaust silencer outlet elbow.

9.5.8.5 Instrumentation

With the locally mounted control switch in the "Auto" position, the diesel crankcase exhauster will start when the engine speed is up to 125 rpm and runs until the engine is shutdown. Crankcase pressure is monitored by pressure switch PS-CCP. High crankcase pressure is alarmed locally and in the main control room.

Intake air filter differential pressure is measured by differential pressure switch PS-SPHA. High differential pressure is alarmed at the local panel and in the main control room.

Locally mounted instrumentation is provided to monitor air manifold pressure and temperature. Locally mounted manometers indicate intake air filter differential and crankcase vacuum.

Locally mounted instrumentation also provides a means of observing exhaust temperature of each of the engine cylinders, combined exhaust of four groups of four cylinders, and the left and right side turbo exhausts.

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CHAPTER 9
AUXILIARY SYSTEMS

TABLES

TABLE 9.1-1 SYSTEM DESIGN DATA

System Cooling Capacity, Btu/hr	See Table 9.1-3
System Design Pressure, psig	150
System Design Temperature, °F	200
Boron Concentration, ppm	2,000 (minimum); 2,400-2,600 (nominal)

SAFETY CLASS
COMPONENT DESIGN DATA

Components	Design Data	ANSI N18.2 Safety Class	Code
Spent Fuel Pool Cooling Pump			
Quantity	3	3	ASME III
Type	Horizontal, centrifugal		Class 3
Material	Stainless steel	3	ASME III
Flow (each), gpm	1100		Class 3
Head (each), ft	43		
Design pressure, psig	150		
Design temperature, °F	225		
Motor horsepower	20		
SFP Cooling Heat Exchanger			
Quantity	2 [1][1]	3	ASME III
Type	Counter flow		Class 3
Installation	Horizontal		

[1] Alternate SFP Heat Exchange data in [ ].

Components	Design Data	ANSI N18.2 Safety Class	Code
Design heat transfer rate, Btu/hr.	$29.6x10^6$ [$21.9x10^6$]		
Effective heat transfer area, ft^2	3037		
Shell side - design			
Design pressure, psig	150		
Design temperature, °F	200		
Primary component cooling [Service Water] flow rate, gpm	3000 [3000]		
Primary component cooling [Service Water] water temperature (in.), °F	95 [85]		
Primary component cooling [Service Water] water temperature (out), °F	114.8 [99.6]		
Fouling factor, hr-ft^2 - F/Btu	0.0005		
Material	Carbon steel		
Tube side - design		3	*ASME III*
Design pressure, psig	150		Class 3
Design temperature, °F	200		

Components	Design Data	ANSI N18.2 Safety Class	Code
*Spent fuel pool water flow rate, gpm	2260		
Spent fuel pool water Temperature (in.), °F	150 [140]		
Spent fuel pool water Temperature (out), °F	123.2 [100]		
Fouling factor, hr-ft^2 - F/Btu	0.0005		
Material	Austenitic stainless steel		
Piping and Valves Associated With Fuel Pool Cooling			
Material	Stainless steel	3	ASME III
Design pressure, psig	150		Class 3
Design temperature, °F	200		

* Normal 1100 gpm/Design 2260 gpm

TABLE 9.1-2 SPENT FUEL POOL COOLING AND CLEANUP SYSTEM MALFUNCTION ANALYSIS

	Component	Malfunction	Comments and Consequences
1.	Spent Fuel Pool Cooling Pump	Rupture of a pump casing	Pumps can be isolated. Two SFP pumps would be available to ensure that adequate heat removal can be obtained.
2.	Spent Fuel Pool Cooling Heat Exchanger	Tube or shell rupture	Rupture is considered unlikely. Heat exchanger can be isolated for maintenance. The second heat exchanger can provide adequate heat removal under all design conditions.
3.	Spent Fuel Pool Skimmer	Component failure	Spent fuel continues to be cooled by fuel pool cooling pumps and heat exchangers. Optical clarity of pool water may be decreased. Adequate time is available for restoration before unacceptable clarity is reached. Part of cooling flow can be diverted to cleanup loop.
4.	Spent Fuel Pool Purification Loop	Component failure	Loop is isolated from fuel pool cooling loop. Spent fuel continues to be cooled by the fuel pool cooling pumps and heat exchanger. Purity of pool water may be decreased until loop is restored. Adequate time is available for restoration before unacceptable impurity level is reached. A bypass loop is also provided to divert flow to the demineralizer if required.

5.	Spent Fuel Pool Cooling Loop	Pipe rupture	Fuel pool cannot be drained below a level that provides adequate shielding. Sufficient time is available for restoration of cooling. Assured pool makeup water is provided by reactor makeup water system or refueling water storage tank.
6.	Alternate Spent Fuel Pool Cooling Heat Exchanger	Tube or shell rupture	Rupture is considered unlikely. Heat exchanger will see limited operation (approx. 30 days) then laid up for future outage availability. Both the spent fuel pool cooling and service water systems operate at low pressure.

TABLE 9.1-3 SPENT FUEL POOL COOLING AND CLEANUP SYSTEM DESIGN CONDITIONS

Normal Operating Conditions

	Sixteen regions stored; both SFPHXs and pumps operating	SFP filled to capacity including full core offload beginning at 80 hours after shutdown and completed at 133.8 hours;both SFPHXs and pumps operating
Each Operating SFPHX		
Heat Load, 10^6 Btu/hr	8.1	23.22
SF Pump Flow, gpm	1100	1100
PCCW Flow, gpm	810[(1)]	3000
Pool Temperature, °F (max.)	119	140

Abnormal Operating Conditions

	SFP filled to capacity, including full core offload beginning at 80 hours after shutdown and completed at 110 hours; both SFPHXs and two pumps operating with Cooling Tower as the ultimate heat sink
Each Operating SFPHX	
Heat Load, 10^6 Btu/hr	25.03
SF Pump Flow, gpm	1100
PCCW Flow, gpm	3000
Pool Temperature °F (max.)	155.7

(1) Increased PCCW is available under this condition.

Alternate Spent Fuel Pool Cooling (Asfpc)
Heat Load Administratively Controlled
ASFPCHX And One Pump Operating

Operating ASFPCHX	
Heat Load, 10^6 Btu/hr	25.03
SF Pump Flow, gpm	1100
SW Flow, gpm	3000
Pool Temperature °F (max.)	159.1

TABLE 9.1-4 Deleted

TABLE 9.1-5 Deleted

TABLE 9.1-6 Deleted

TABLE 9.2-1 SERVICE WATER SYSTEM[1] FLOWS AND HEAT LOADS

	Normal	Post-LOCA Recirculation With Loss of Offsite Power
Flow per Train, gpm	11,500 (NOM.)	8900[2]
No. Flow Trains Required	2	1
No. Pumps Operating Per Train	1	1
Heat Load, 10^6 Btu/hr.		
Train A	72.9	181.9[3]
Train B	58.7	Not Required

(1) Cooling water supplied by Atlantic Ocean
(2) SW flow rate to the PAB overflow (candycane) vent includes allowance for PCCW heat exchanger tube plugging, SW pump degradation and instrument uncertainties. The flow rate is the sum of diesel generator jacket cooler heat exchanger flow rate and PCCW heat exchanger flow rate.
(3) LOCA and diesel heat loads (24 hour average)

TABLE 9.2-2 SERVICE WATER SYSTEM COMPONENT DESIGN DATA[(1)]

Service Water Pumps

Type:	Vertical, centrifugal
Quantity/Unit	4
Rated Capacity, gpm	9,360
Rated Head, Ft	175
Motor Horsepower, hp	600
Design Pressure, psig	150
Design Temperature, °F	200
Safety Class	3
Code	ASME III, Class 3
Seismic Category	I
Material	Stainless Steel

Service Water Strainers

Type:	Basket
Quantity/Unit	2
Design Flow, gpm	10,500
Design Pressure, psig	150
Design Temperature, °F	200
Safety Class	3
Code	ASME III, Class 3
Seismic Category	I
Material	Rubber lined carbon steel

(1) Those portions of the Service Water System not required to mitigate accident conditions are nonseismic Category I and are designed in accordance with ANSI B31.1. These sections are automatically isolated upon appropriate safety signals.

Piping & Valves

Design Pressure, psig	150
Design Temperature °F	200
Safety Class	3
Code	ASME III, Class 3
Seismic Category	I

TABLE 9.2-3 FAILURE ANALYSIS OF STATION SERVICE WATER SYSTEM AND COMPONENTS

Component	Failure	Comments and Consequences
1. Service water pump	Pump fails to start	a) The redundant flow train supplied by either of its service water pumps provides 100 percent of the flow required to dissipate LOCA heat loads during a loss of offsite power. b) The standby pump can supply 100 percent of required flow to its train if the online pump is tripped. If the online pump fails to start and is not tripped, a tower actuation signal will trip the online pump and automatically start the respective train cooling tower and cooling tower pump, which can provide 100 percent of the required cooling.
2. Service water pump	Valve on pump discharge fails to open	During normal operation, both flow trains are operating and aligned for safeguards condition. The pump discharge valve is interlocked to open after the pump is started. If a valve fails to open in either flow train after the pump is started, alarms are provided. The associated pump is tripped by the operator and the standby pump starts. If the online pump is not tripped, a tower actuation signal will trip the online pump and automatically start the respective train cooling tower and cooling tower pump, which can provide 100 percent of the required cooling.

Component	Failure	Comments and Consequences
3. Isolation valve to secondary component cooling water heat exchangers	Valve fails to close	a) Valve in redundant line shuts enabling redundant flow train to supply the necessary flow as in 1.a. b) High temperatures in the PCCW system and the Diesel Generator Cooling System will identify the malfunctioning SW train which along with served systems will be shut down.
4. Isolation valve on line supplying Service Water Pumphouse	Valve rupture or fails to open	a) Rupture is unlikely since this is a Safety Class 3 line and valve must meet all requirements of the ASME Code Section III. b) Valve is normally open.
5. System piping	Piping develops through wall crack	a) (Same as 1.a). Also the failure in the affected train is identified and isolated or shut down before excessive flooding, basin water loss, or temperature increases occur. b) The failure will be detected before excessive basin water loss or temperature increases occur. The redundant train is protected against the effects of fresh or sea water jet impingement. c) Failure in the NNS lines to the SCCW HX, while the system flow is from the ocean water pumps, will not cause cooling flows to fall below minimums. Flows will continue to exceed mini-mums for any size rupture to and including a full guillotine break. Detection is from sump levels if the rupture is inside the Turbine Building, if underground detection is visual.

Component		Failure	Comments and Consequences
6.	Isolation valves on return line to discharge transition structure, or on lines to the secondary CC HXs	Valve fails to close on tower actuation signal	a) The affected train is identified and shut down before basin water losses exceed allowables. The redundant train provides 100 percent of the heat removal capacity required. b) Failure of the valve to close is determined either by control room valve positioning lights, by low cooling tower return flow, or by a dropping basin level. After detection the affected train is identified, and the affected train and served systems are shut down.
7.	Isolation valves on lines at intake and discharge transition structure	Valve moves to wrong position or fails to move to correct position	a) A loss of flow or increase in water temperature is identified before allowables are exceeded. The cooling tower circuit provides 100 percent of the heat removal capacity required. b) A loss of flow exceeding allowables automatically initiates a TA signal which switches cooling from ocean water to cooling tower water. High ocean cooling water temperature is identified by the operator who initiates a TA signal before allowables are exceeded.
8.	Service water cooling tower pump spray recirculation valve or discharge valve	Pump fails to start or valves fail to complete startup sequence following a TA signal	a) The redundant flow train provides 100 percent of the heat removal capacity required, with or without a loss of offsite power. b) The failure of the pump start-up sequence identifies the malfunctioning train which, along with served systems, should be shutdown.

Component		Failure	Comments and Consequences
9.	Service Water Cooling Tower	Fan fails to start or spray bypass valve fails to close following TA	a) Function lights on the MCB indicate the failure of components. The affected train is shut down before temperatures exceed allowables, and the redundant train provides 100 percent of the heat removal capacity required. b) An administrative check that manual functions of the operator have been performed is made to identify and correct a failure of the operator to operate sprays and fans before temperatures exceed allowables.
10.	Check valves	Sticks in position or sticks in position initially then slams during pressure transient	a) This failure is prevented by implementation of a plant maintenance program. The effects of fresh and sea water on valve parts are limited by chlorinating the water and frequent inspection, reconditioning and replacement of valve parts and assemblies.

Component	Failure	Comments and Consequences
11. Service Water Cooling Tower	Operator starts sprays or sprays and fans before temperature of water entering sprays is sufficiently high to avoid incapacitating icing.	a) This failure is prevented by requiring operator to determine that the temperature of the water entering the sprays is sufficiently high when outside temperatures are below freezing before starting sprays or fans. During the sprays or sprays and fans operations, the operator is required to periodically monitor temperature conditions to shut down the sprays or fans if temperatures change sufficiently to cause the possibility of icing. b) An administrative check that manual functions to be performed by the operator have been performed is made to identify and correct a failure of the operator to regulate water temperatures to prevent incapacitating icing of the tower. c) The tower will be inspected during cold weather operation to detect the onset of icing.
12. Service Water Cooling Tower and valves	Debris or failed piping lining clogs cooling tower sprays or prevents valve operation	a) This failure is detected by periodic visual inspection of components and periodic comparison of flow, pressure and temperature conditions for abnormalities indicative of clogging. Valve malfunction is detected by verification of position indication, flows, basin level and temperatures each time valve positions are changed. b) After detection, the condition is corrected if possible before limits are exceeded or the plant or subsystem is shutdown if limits could be exceeded.

TABLE 9.2-4 PRIMARY COMPONENT COOLING WATER SYSTEM PERFORMANCE REQUIREMENTS, (LOOPS A AND B)

	Normal Operation	Normal Plant Cooldown 4 hr/24 hr	Extended Cool down (4 Hrs)	Post-LOCA[(a)] (Ocean or Cooling Tower as UHS)
Cooling Water Supply Temperature, (max.) °F	85	102/85	102	120 [(b)]
No. of Loops Required	2	2	1	1
Serv. Wtr. Supply Temp., °F[(c)]	65	65	65	65/90[(d)]
Required Flow (gpm)				
Loop A	10,677	7937	7382	10926
Loop B	9747	7677	7422	11011
Heat Loads (x 10/^{6} Btu/Hr.)				
Loop A	44.9	146.0/65.6	215.4	166.4
Loop B	28.8/30.7	142.5/62.1	213.7	166.4

Note:

Only one primary component cooling water pump per loop is required for any mode of operation.

(a) Heat loads shown are average over the first 24 hours after post-LOCA recirculation begins.

(b) For the design basis accident with cooling tower operation, the system will experience a peak temperature of approximately 125°F at initiation of recirculation. Based on the brief duration of this transient, this will have an insignificant impact on piping stress.

(c) System analysis has been performed to permit plant operation up to a maximum ocean temperature of 68.5ºF to accommodate occasional summer ocean temperature excursions.

(d) Service water temperature is 65°F with ocean as UHS, and 90°F with cooling tower as UHS.

TABLE 9.2-5 PRIMARY COMPONENT COOLING WATER SYSTEM HEAT LOADS, X 10^6 BTU/HR

Loop A	Normal Operation	Normal [(1)] Plant Cooldown 4 hr/24 h	Extended [(2)] Cooldown 4 Hrs	Post-LOCA (Ocean or Cooling Tower as UHS)
Containment Spray Pump	---	---	---	.18
Safety Injection Pump	---	---	---	.075
RHR Pump	---	.075	.075	.075
Containment Spray HX	---	---	---	74.8[(a)]
RHR HXs	---	119/39.1[(3)]	180.6[(3)]	85.3[(a)]
Sample HXs	1.6	1.6	1.6	---
Centrif. Charging Pump	.08	.08	.08	.08
Containment Encl. Fan Cooler	.73	.73	1.18	1.18
Containment Str. Cooling Units	3.7	3.7	3.7	---
Reactor Coolant Pumps (2 pumps)	4.8	2.4	2.4	---
Spent Fuel Pool HX [(4)]	8.11	8.11	16.22	16.22[(5)]
Letdown HX	6.51	1.2	1.2	---
Seal Water HX	1.6	.75	.75	.75
Letdown Degasifier Trim Cooler	1.64	3.0	---	---
Letdown Degas. Hotwell Condenser	.05	.05	---	---
Reactor Coolant Dr. Tank HX	2.43	2.43	---	---
Waste Gas Compressor (C-5A & C-6)	.27	.27	.27	---
Instrument Air Compressor	.14	.14	.14	---
Mech. Seal HX	.02	.02	---	---
Thermal Barrier HX	.4	.4	5.6	2.4
Steam Gen. Bldn. Hx.-142	11.2/-	---	---	---
Pumping & Friction Heat	1.58	1.58	1.58	1.58
Total Unit 1	44.9	146.0/65.6	215.4	166.4

(1) Cooldown of Reactor Coolant system to 125°F in 24 hours.

(2) Extended cooldown is a cooldown with only one flow train in operation.

(3) Reference Westinghouse letter NAH-03-73, LTR-IPES-03-179

(4) Spent fuel pool heat load is based on storing sixteen spent fuel regions in the spent fuel pool.

(5) Heat load is not transferred initially but is imposed following recirculation peak load and is not included in totals.

(a) Heat loads shown are average over the first 24 hours after post-LOCA recirculation begins

Loop B	Normal Operation	Normal[1] Plant Cooldown 4 Hrs/24 Hrs	Extended [2] Cooldown 4 Hrs	Post-LOCA (Ocean or Cooling Tower as UHS)
Containment Spray Pump	---	---	---	.18
Safety Injection Pump	---	---	--	.075
RHR Pump	---	.075	.075	.075
Containment Spray HX	---	---	---	74.8[a]
RHR HX	---	119.5/39.1[3]	181.6[3]	85.3[a]
Centrif. & Recip. Ch. Pumps	.48	.08	.08	.08
Containment Encl. Fan Cooler	.73	.73	1.18	1.18
Containment Str. Cooling Units	3.7	3.7	3.7	---
Reactor Coolant Pumps (2 pumps)	4.8	2.4	2.4	---
Spent Fuel Pool HX[4]	8.11	8.11	16.22	16.22[5]
Primary Drain Tank Degasifier	1.64	3.0	---	---
Prim. Drain Tk. Degas. Hotwell Cond.	.048	.048	---	---
Purge Gas Cond. & Comp. C-5B	.14	.14	.14	---
Instrument Air Compressor	.14	.14	.14	---
Steam Gen. Bldn. Fl. Tk. Cooler	1.2/3.12	---	---	---
Pzr. Rel. Tank HX	2.43	---	---	---
Seal Water HX	1.6	.75	.75	.75
Mech. Seal HX	.02	.02	---	---
Thermal Barrier HX	2.0	2.0	5.6	2.4
Stm. Gen. Bldn. Rad. Monitor	.2	.2	.2	---
Pumping & Friction Heat	1.58	1.58	1.58	1.58
Total Unit 1	28.8/30.7	142.5/62.1	213.7	166.4

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(1) Cooldown of Reactor Coolant system to 125°F in 24 hours.

(2) Extended cooldown is a cooldown with only one flow train in operation.

(3) Reference Westinghouse letter NAH-03-73, LTR-IPES-03-179.

(4) Spent fuel pool heat load is based on storing sixteen spent fuel regions in the spent fuel pool.

(5) Heat load is not transferred initially, but is imposed following recirculation peak load and is not included in totals.

(a) Heat loads shown are average over the first 24 hours after post-LOCA recirculation begins

TABLE 9.2-6 PRIMARY COMPONENT COOLING WATER SYSTEM FLOW, GPM [15]

Loop A	Normal Operation (w/Leakage)	Normal [1] Plant Cooldown	Extended [4] Cooldown	Post – LOCA (Ocean or Cooling Tower as UHS)
Containment Spray Pump	26	26	26	26
Safety Injection Pump	10	10	10	10
RHR Pump	5	5	5	5
Containment Spray HX	---	---	---	4800
RHR HX	5000 [14]	2960	2960	5000
Sample HXs	64	64	64	---
Centrifugal Charging Pump	30	30	30	30
Containment Encl. Fan Coolers	325	325	325	325
Containment Str. Cooling Units	990	990	990	---
Reactor Coolant Pumps (2 pumps)	1112	1112[5]	1112[5]	---
Spent Fuel Pool HX	810	810	810	810[11]
Letdown HX	600	300	300	---
Seal Water HX	250	250	250	250
Letdown Degasifier Trim Cooler	80	240	---	---
Letdown Degas. Hotwell Condenser	15	15	---	---
Reactor Coolant Dr. Tank HX	300	300	---	---
Waste Gas Compressors (C-5A & C-6)	4	4	4	---
Instrument Air Compressor	4	4	4	---
Mech. Seal HX	12	12	12	---
Thermal Barrier Hx	480	480	480	480
Steam Gen. Bldn. Hx-142	560/(560) [12]	---	---	---
Total Unit 1[13]	10,677	7937	7382	10926

Loop A

(1) Cooldown of Reactor Coolant system to 125°F in 24 hours.

(2) Not used.

(3) Not used.

(4) Extended cooldown is a cooldown with only one flow train in operation.

(5) Cooling flow provided to both reactor coolant pumps, although only one is operating.

(6) Not used.

(7) Not used.

(8) Not used.

(9) Not used.

(10) Not Used.

(11) Flow is initially isolated but required following peak heat load to cool spent fuel and is not included in totals.

(12) Either the SGBHX or SGB Evap. is operated. If both are required, cooling water to one of the other evaporators must be reduced. The SGB Evaporator is not normally in service.

(13) Does not include small (2 gpm) flow to radiation monitor RE 6516 during all modes of operation

(14) With flow isolated from waste process building equipment not in service, PCCW is provided through the RHR heat exchanger. 5000 gpm is a maximum flow value in this mode. There is no heat load in this mode, but normal minimum flow is 3000 gpm to provide PCCW pump flow in the desired range.

(15) Except as otherwise noted, flow values are design minimum flow rates for each component, when in service. Actual total flow rates are higher than the listed values.

(16) Not used.

(17) Not used.

(18) Not used.

TABLE 9.2-6 PRIMARY COMPONENT COOLING WATER SYSTEM FLOW, GPM [17]

Loop B[17]	Normal Operation (w/Leakage)	Normal [1] Plant Cooldown	Extended Cooldown[4]	Post – LOCA (Ocean or Cooling Tower as UHS)
Containment Spray Pump	26	26	26	26
Safety Injection Pump	10	10	10	10
RHR Pump	5	5	5	5
Containment Spray HX	---	---	---	4800
RHR HX	5000 [16]	2960	2960	5000
Centrif. & Recip. Ch. Pumps	115	115[10]	115[10]	115[10]
Containment Encl. Fan Cooler	325	325	325	325
Containment Str. Cooling Units	990	990	990	---
Reactor Coolant Pumps (2 pumps)	1112	1112[5]	1112[5]	---
Spent Fuel Pool HX	810	810	810	(810)[11]
Primary Drain Tank Degas. Trim. Clr.	80	240	---	---
PDT Degas. Hotwell Cond.	15	15	---	---
Purge Gas Cond. & Comp. C-5B	3	3	3	---
Instrument Air Compressor	4	4	4	---
Steam Gen. Bldn. Fl. Tank Btm. Clr.	190/190 [21]	---	---	---
Pzr. Rel. Tank HX	300[15]	300[15]	300[15]	---
Seal Water HX	250	250[14]	250[14]	250
Mech. Seal HX	12	12	12[14]	---
Thermal Barrier HX	480	480	480	480
Steam Gen. Bldn. Rad. Monitor	20	20	20	---
Total Unit 1[13]	9747	7677	7422	11011

Loop B

(1) Cooldown of Reactor Coolant system to 125°F in 24 hours.
(2) Not used.
(3) Not used.
(4) Extended cooldown is a cooldown with only one flow train in operation.
(5) Cooling flow provided to both reactor coolant pumps, although only one is operating.
(6) Not used.
(7) Not used.
(8) Not Used.
(9) Not used.
(10) Reciprocating charging pump not used but flow is provided.
(11) Flow is initially isolated but required following peak heat load to cool spent fuel and is not included in totals to cool spent fuel.
(12) Not used.
(13) Does not include small (2 gpm) flow to radiation monitor RE 6516 during all modes of operation
(14) Full flow provided to all components although not required.
(15) Full flow provided in standby mode.
(16) With flow isolated from waste process building equipment not in service, PCCW flow is provided through the RHR heat exchanger. 5000 gpm is a maximum flow value in this mode. There is no heat load in this mode, but normal minimum flow is 3000 gpm to provide PCCW pump flow in the desired range.
(17) Except as otherwise noted, flow values are design minimum flow rates for each component, when in service. Actual total flow rates are higher than the listed values.
(18) Not used.
(19) Not used.
(20) Not used.
(21) The PCCW flow rate during normal operation may be maintained at 961 gpm or higher, similar to the plant startup mode.

TABLE 9.2-7 PRIMARY COMPONENT COOLING WATER SYSTEM COMPONENT DESIGN DATA·

Primary Component Cooling Water Pumps

Quantity	4
Type	Horizontal centrifugal
Rated Capacity (each), gpm	11,000
Rated Head, ft H_2O	200
NPSHR, ft[(a)]	28
NPSHA, ft[(a)]	47
Motor horsepower, hp	700
Material	Cast carbon steel
Design pressure, psig	150
Design temperature, °F	200
Code	ASME III Class 3
Seismic Category	I

Primary Component Cooling Water Heat Exchangers

Quantity	2
Type	Vertical shell, straight tube
Code	ASME III Class 3
Seismic Category	I
Design heat transfer, Btu/hr	$326x10^6$

Shell Side (Primary Component Cooling Water)

Operating outlet temperature, °F(b) (e)	124.2
Design flow rate, lb./hr(b)	5.85×10^6
Design pressure, psig	150
Design temperature, °F	200
Material	Carbon steel

Tube Side (Service Water)

Operating inlet temperature, °F(b)	65°
Design flow rate, lb./hr(b)	3.925×10^6
Design pressure, psig	150
Design temperature, °F	200
Tube material	Titanium

Primary Component Cooling Water Head Tank

Quantity	2
Volume, gal.	2000
Design pressure, psig	100
Design temperature, °F	200
Material	Carbon steel
Code	ASME III Class 3
Seismic Category	I

Primary Component Cooling Water Piping and Valves

Design pressure, psig	150
Design temperature, °F	200
Material	Carbon steel/Stainless steel
Code	ASME III Class 2 & 3 (See Figures 9.2-3 through 9.2-6) ANSI B31.1.0 (NNS Piping)
Seismic Category	I (Safety Class portions only) and IA (ANSI B31.1.0 piping as indicated on Figures 9.2-3 through 9.2-6)

Thermal Barrier Loop Circulating Water Pumps

Quantity	2
Type	Horizontal Centrifugal
Rated capacity, gpm/pump	180; 220 normal operating flow
Rated head, ft H_2O	307
NPSHR, ft	8.5
NPSHA, ft	33[(c)]
Motor horsepower, hp/pump	30
Material	Cast carbon steel
Design pressure, psig	150, normal
Design temperature, °F	200, normal
Code	ASME III, Class 3
Seismic Category	I

Thermal Barrier Loop Heat Exchangers

Quantity		
Type	Horizontal 2 shell & U-tube	
Safety Class	3 shell side, 2 tube side	
Code	ASME III Class 3 for shell and 2 for tube side.	
		Following A MSL Break Assuming Loss of Loop A or B and Loss of RCP Seal Injection
		HX A or B
Design heat load, Btu/hr		5.64×10^6
Shell Side Design		
Temperature In		176.1°F
Out		105°F
Flow Rate lbs./hr		8.0×10^4
(gpm)		(160)
Temperature, °F		200
Pressure, psig		150
Material		Carbon Steel
Tube Side Design		
Temperature In		85°F
Out		108.3°F
Flow Rate lbs./hr		24.0×10^4
(gpm)		(480)

Temperature, °F		200
Pressure, psig		150
Tube Material		Stainless Steel

Thermal Barrier Head Pipe

Quantity	1
Volume, gal	370
Design pressure, psig	50
Design temperature, °F	300
Material	Carbon steel
Code	ASME III, Class 3
Seismic Category	I

Thermal Barrier Loop Piping and Valves

Design pressure, psig	300-2500[(d)]
Design temperature, °F	200-600[(d)]
Material	Carbon Steel
Code	ASME III, Classes 2 and 3[(d)]
Seismic Category	I (Safety class portions only)

Notes:

(a) During post-LOCA recirculation
(b) Initiation of post-LOCA recirculation tower operation
(c) During the emergency temperature condition of 212°F
(d) See Figure 9.2-13
(e) For the design basis accident, this equipment will experience a 6°F cooling water supply temperature transient (120°F to 126°F to 120°F) over a 1½ hour period, or 3°F for a period of 5 hours (cooling tower operation, which will have an insignificant impact on analysis of piping stresses.

TABLE 9.2-8 COMPONENTS HAVING A SINGLE BARRIER BETWEEN PRIMARY COMPONENT COOLING WATER AND REACTOR COOLANT WATER

	Barrier Design Temp. °F	Barrier Design Press, psig	Temperature Range of Reactor Coolant Water, °F	Pressure Range of Reactor Coolant Water, psig
1. RHR Heat Exchangers	400	600	≤350	≤600
2. RHR Pumps (Seal Coolers)	400	600	≤350	≤600
3. Letdown Heat Exchanger	400	600	≤380	≤600
4. Excess Letdown Heat Exchanger	650	2485	≤600	≤2485
5. Seal Water Heat Exchanger	250	150	≤200	≤150
6. Pressurizer Sample Heat Exchanger	650	2485	≤600	≤2485

TABLE 9.2-9 FAILURE ANALYSIS OF PUMPS, HEAT EXCHANGERS AND VALVES

	Component	Failure	Comments and Consequences
1.	Primary component cooling water pump	Rupture of pump casing	(a) The casing and shell are designed for 150 psi and 200°F, which exceed maximum operating conditions. Pump is inspectable and protected against credible missiles. Rupture is not considered credible. However, each loop can be isolated. (b) A single loop A or B pump provides adequate flow for cooling after a loss of reactor coolant accident.
2.	Primary component cooling water pump	Pump fails to start	(Loop A or B same as 1.b). If the thermal barrier loop pump fails to start, the standby pump provides adequate flow.
3.	Primary component cooling water pump	Valve on a pump suction, or discharge line closed	This is prevented by pre-startup and operational procedures. During normal operation, each pump is started using an operating procedure which should preclude any valve misoperation. (Same as 1.b).
4.	Primary component cooling water heat exchanger	Tube or shell rupture	Rupture is considered improbable because of the low operating pressures. Loop A and B can be isolated, and the redundant primary component cooling water loop is capable of providing the necessary cooling. A thru-wall crack in the shell side of one of the RCP thermal barrier heat exchangers will force a shutdown of the loop; the RCP seals are then cooled by the RCP Seal Injection System only.

	Component	Failure	Comments and Consequences
5.	Primary component cooling heat exchanger shell side vent or drain valve	Left open	Prevented by pre-startup and operational procedures. This situation is readily assessed by makeup requirements to the system. A significant loss of inventory will result in a head tank low level alarm.
6.	Primary component cooling water piping	Rupture	The redundant loop A or B flow loop is capable of providing component cooling water to all the safeguards components (on that loop). A single primary component cooling water loop can provide the cooling capacity necessary during a loss-of-coolant accident. A thru-wall crack in the RCP thermal barrier loop piping will force a shutdown of the loop; the RCP seals are then cooled by the RCP Seal Injection System only.
7.	PCCW temperature control	Single failure in temperature control	The redundant train provides 100 percent of the required heat removal after a LOCA. If the failure causes maximum or near maximum heat removal, consequences are the same as when failure with air supply develops a thru-wall crack. If failure causes minimum or near minimum heat removal, the affected train will be shut down if a high temperature condition results.
8.	Service water cooling of PCCW heat exchanger	Single failure causes loss of PCCW cooling	The redundant train provides 100 percent of the required heat removal after a LOCA. If the failure causes loss of required cooling, the affected PCCW train will be shutdown if a high temperature condition results.
9.	RCP heat exchanger (thermal barrier)	Develops a thru-wall crack	A thru-wall crack in one of the two RCP thermal barriers heat exchangers can result in reactor coolant discharge into containment, and can force a shutdown of the thermal barrier cooling loop.

	Component	Failure	Comments and Consequences
10.	PCCW temperature control air supply	Develops thru-wall crack	Operator action will limit any resulting low temperatures to less than the time duration allowed by vendors of the equipment that could be affected by the low temperatures.

TABLE 9.2-10 DEMINERALIZED WATER MAKEUP SYSTEM EQUIPMENT DATA

	Component	Wetted Material
1)	Carbon Filters	15 Mils Phenolic
2)	MWTS Feed System	316SS, PVC
3)	MWTS Ultrafiltration System	316SS, PVC
4)	MWTS Reverse Osmosis System	316SS, PVC
5)	MWTS Electrodeionization System	316SS, PVC
6)	MWTS Catalytic Oxygen Reduction (CORS) System	316SS
7)	MWTS Ion Exchange System	Fiberglass, PVC
8)	MWTS Chemical Feed System	316SS, PVC
9)	MWTS Reject Waste Collect/Pumping System	316SS, PVC
10)	Neutralization Tank	Fiberglass
11)	Air Distributor	Polyvinyl Chloride
12)	Overboard and Recirculation Pumps	316SS
13)	Demineralized Water Storage Tanks	304SS
14)	Demineralized Water Transfer Pumps	316SS
15)	Demineralized Water Storage Tank Heat Exchangers	
	a) Shell	Carbon Steel
	b) Tubes	304SS
16)	Piping and Valves in Transfer System	316, 304SS, or 304L
17)	Demineralized Water Storage Tank Recirculation Pump	316SS

TABLE 9.2-11 WATER TREATMENT CONTROL PANEL DATA

Parameters	Indicating and/ or Recorded	Condition Alarmed
A. ***Leased Makeup Water Treatment Control Panel Data Feed System***		
MWTS Influent Pressure	No	High and Low Pressure
Ultrafiltration Feed Pressure	No	High and Low Pressure
Motor - UF Feed Pump	No	Motor Failure
Utrafiltration System (Note 1)		
Reject Flow Rate	Yes	None
Permeate Flow Rate	Yes	None
Permeate Conductivity	Yes	High Conductivity
Permeate pH	Yes	High and Low pH
Reverse Osmosis System (Note 1)		
Inlet Pressure RO Feed Pump	No	High and Low Pressure
RO Feed Pump Discharge Pressure	No	High and Low Pressure
Motor - RO Feed Pump	No	Motor Failure
RO Membrane Differential Pressure	Yes	None
RO Product Flows	Yes	None
RO Effluent Pressure	No	High and Low Pressure
RO Effluent Conductivity	Yes	High Conductivity
RO Reject Flow	Yes	None

(Note 1) Instrumentation on Common UF/RO Control Panel

Parameters	Indicating and/ or Recorded	Condition Alarmed
EDI System (Instruments mounted locally on EDI skid panel)		
Influent pH	Yes	None
Influent Flows	No	Low Flow
Influent Pressure	Yes	High and Low Pressure
Motor-EDI Brine Pump	No	Motor Failure
Salt Feed Conductivity	Yes	High Conductivity
EDI Effluent Conductivity	Yes	High Conductivity
EDI Effluent Pressure	No	High and Low Pressure
Stack Differential Pressure	Yes	None
Motor-EDI Gas Blower	No	Motor Failure
Pressure-EDI Gas Blower	No	Low Pressure
CORS System (Instruments mounted locally on CORS skid panel)		
Inlet Pressure - CORS Feed Pump	No	High and Low Pressure
Motor - CORS Feed Pump	No	Motor Failure
Oxygen Content - CORS Influent	Yes	High Oxygen Content
CORS Effluent Conductivity	Yes (On Ion-exchange skid)	High Conductivity
Hydrogen Content CORS Effluent	Yes	High Hydrogen Content
Discharge Pressure - CORS Feed Pump	No	High Pressure
Differential Pressure CORS Degas Blower	No	Low Diff. Pressure

Parameters	Indicating and/ or Recorded	Condition Alarmed
Hydrogen Source Pressure	No	High Hydrogen Pressure
CORS Effluent Pressure	No	High and Low Pressure
Hydrogen Content - CORS Effluent	Yes	High and Low Pressure
Hydrogen Supply Pressure	Yes	High and Low Pressure
CORS Effluent Flow	Yes	None
Ion Exchange System (Instruments mounted locally on bottle bank)		
Primary Bank Effluent Conductivity	Yes	High Conductivity
Polishing Bank Effluent Conductivity	Yes	High Conductivity
TOC	Yes	High TOC
Conductivity	Yes	High Conductivity
Silica Content	Yes	High Silica Content
Sodium Content	Yes	High Sodium Content
Oxygen Content	Yes	High Oxygen Content
pH	Yes	High pH
Diverter Valve Open/Close	Yes	None
Effluent Interconnecting System (Instruments mounted locally on skid)		
Motor - Effluent Sump Pumps	No	Motor Failure

Parameters	Indicating and/ or Recorded	Condition Alarmed
B. Existing Water Treatment Control Panel Data		
Water Treatment Subsystem Equipment		
Water Supply Conductivity	Yes	High Conductivity
Differential Pressure - Carbon Filter	Yes	High Diff. Pressure
UV Sterilizer	Yes	Trouble
Neutralization Subsystem Equipment		
Neutralization Tank Level	Yes	High Level
(Note 1)		

TABLE 9.2-12 COOLING TOWER (FUNCTIONAL PORTION) DESIGN DATA

Cooling Tower

Quantity (onsite)	1	
Type	Mechanical Draft Evaporative	
Design Wet Bulb Temperature, °F	75	
Approach, °F	15	
Cold Water Temperature, °F	90	
Seismic Category	I	
	Independent Cell	***Center Cell***
No. of Cells	1	1
Design Heat Load, 10^6 Btu/hr	217.5	240
Flow Rate, gpm	13,000	15,000
No. of fans	1	2
Fan Motor Hp	400	250 (each)
Maximum Drift, % (Flow)	.03	
Total Basin Capacity, gallons	3.9×10^6	
Basin Capacity available for makeup, gallons	3.38×10^6	
Internal Tower Piping		
Material	Carbon Steel	
Coating, inside	Plasite #7122	
Code	ASME III, Class 3	
Seismic Category	I	
Material	Stainless Steel	

Cooling Tower Pumps Category

Type:	Vertical, Centrifugal
Quantity (onsite)	2
Rated Capacity, gpm	12,140
Rated Head, ft	180
Motor Horsepower, hp	800
Design Pressure, psig	150
Design Temperature, °F	200
Safety Class	3
Code	ASME III, Class 3
Seismic Category	I
Material	Stainless Steel

Portable Tower Makeup Pump (Diesel Engine Driven)

Quantity	1
Type:	Portable Horizontal Centrifugal
Rated Capacity, gpm	300
Rated Head, Ft H_2O	270
Diesel Horsepower, hp	80
Material	Stainless Steel
Design Pressure, psig	212
Design Temperature, °F	120
Safety Class	NNS

NOTE: Design data for plant components services by the cooling tower is supplied in Subsection 9.2.1, Station Service Water System

TABLE 9.2-13 SEABROOK STATION ULTIMATE HEAT SINK COOLING TOWER (FUNCTIONAL PORTION) HEAT LOADS AND FLOWS HEAT LOAD (x10^6 BTU/HR) @ FLOW (GPM).

	Unit 1 Operating(1)		
	LOCA One Diesel Failed	LOCA Both Diesels Operating	Refueling w/(3) Alternate Spent Fuel Pool Cooling (ASFPC)
Independent Cell - Unit 1	(2)	(2)	
PCCW HX (A Train)	255.3 @ 9,860	255.3 @ 9,860	ASFPC HX 21.9 @3,000
Diesel HX (A Train)	15.55 @ 1,800	15.55 @ 1,800	Diesel HX 15.5 @1,800
Total Cell Load	270.85 @ 11,660	270.85 @ 11,860	37.4 @ 4,800
Center Cell		(2)	
PCCW HX (B Train)		255.3 @ 9,860	ASFPC HX 21.9 @3,000
Diesel HX (B Train)		15.55 @ 1,800	Diesel HX 15.5 @1,800
Total Cell Load		270.85 @ 11,860	37.4 @4,800
Number of Tower Fans Operating	1	3	1

Notes:

(1) Two common cell fans powered by one diesel.

(3) For ASFPC either the independent cell or center cell is in operation.

(2) Maximum transient heat load occurring during LOCA.

TABLE 9.2-14 INTEGRATED HEAT LOADS FOR COOLING TOWER MAKEUP REQUIREMENTS

	0 to 7 Days ($x10^9$ Btu)	7 to 30 Days ($x10^9$ Btu)	Total - 30 Days ($x10^9$ Btu)
Sensible Heat	0.6	0	0.6
Total Decay Heat	10.1	20.8	30.9
Auxiliaries	0.5	1.7	2.3
Diesels	2.6	8.3	10.9
	13.8	30.8	44.7

TABLE 9.2-15 SUMMARY OF REACTOR MAKEUP WATER REQUIREMENTS

System	Component Supplied	Required Flow and Pressure at Component	Purpose
Chemical and Volume Control	Boric Acid Blender(CS-MM-1)	120 gpm @ 95 psig	Reactor coolant makeup
	Charging Pump Suction(CS-P-128, 2A, 2B)	120 gpm @ 35 psig	Reactor coolant makeup alternate path
	Boric Acid Batching Tank (CS-TK-5)	40 gpm @ Atm.	Production of boric acid solution
	Chemical Mix Tank (CS-TK-2)	5 gpm @ 35 psig	Addition of chemicals
	Thermal Regenerative Demineralizers (via CS-E-8) (CS-DM-3A, B, C, D, E)	60 gpm @ 100 psig	Alternate bed regeneration method
	Resin Fill Tank (CS-TK-15)	20 gpm @ Atm.	Resin fill of demineralizers
Containment Spray	Spray Additive Tank (CBS-TK-13)	20 gpm @ Atm.	Mixing of chemicals flushing and dilution
Reactor Coolant	Pressurizer Relief Tank (RC-TK-11)	150 gpm @ 65 psig	Cooling of RC relief valve discharge
	Reactor Coolant Pump Seal Standpipes	10 gpm @ Atm.	Standpipe fill and makeup
Spent Fuel Pool Cooling and Cleanup	Spent Fuel Pool	20 gpm @ Atm.	Pool makeup
Boron Recovery	Resin Fill Tank (BRS-TK-113)	20 gpm @ Atm	Resin fill of demineralizers
	Recovery Test Tank Demineralizer (BRS-DM-14A, B)	100 to 115 gpm	Recirculation for cleanup of RMW liquid

System	Component Supplied	Required Flow and Pressure at Component	Purpose
Spent Resin Sluicing	Resin Sluice Tank (RS-TK-79A, B)	200 gpm @ Atm.	Backflush of tank filter element
	Resin Sluice Filter (RS-F-13)	200 gpm @ Atm.	Backflush of filter
Waste Liquid Drain	Reactor Coolant Drain Tank (WLD-TK-55)	50 gpm @ Atm.	Hydrogen purge prior to maintenance
Solid Waste	Various	100 psig	Line flush

TABLE 9.2-16 REACTOR MAKEUP WATER SYSTEM EQUIPMENT DATA

A. Reactor Makeup Water Pumps

Number	2
TDH at Capacity (each)	360 feet at 150 gpm; 270 feet at 280 gpm
Material	Austenitic Stainless Steel (316 SS)
Design Pressure	200 psig
Design Temperature	150°F
Design Code	ANSI B73.1
Safety Class	NNS

B. Reactor Makeup Water Storage Tank

Number	1
Capacity	112,000 gallons
Material	Austenitic Stainless Steel
Design Pressure	Atmospheric
Design Temperature	150°F
Design Code	API 650
Safety Class	NNS

C. Piping and Valves

Material	Austenitic Stainless Steel
Design Pressure	200 psig
Design Temperature	150°F
Design Code	ANSI B31.1.0, ASME III
Safety Class	NNS and Safety Class 2 & 3

D. Containment Isolation Piping Valves

Material	Austenitic Stainless Steel
Design Pressure	250 psig
Design Temperature	150°F
Design Code	ANSI B31.1.0, ASME III
Safety Class	NNS and Safety Class 2

TABLE 9.2-17 Deleted

TABLE 9.3-1 SAMPLES FROM SAMPLING SYSTEM

Type Of Sample

A - Atmospheric pressure

LF - Low pressure

P - Pressurized

L - Liquid

G - Gas

System	Sample Source	Analysis	Type Sample	Purpose	Application
A. Normal Sampling:					
Reactor Coolant	Reactor Coolant Loops	Boron Concentration	A-L	Detect nonuniformity when changing concentration	Avoid undesirable reactivity insertion
	Pressurizer Liquid	Boron Concentration	A-L	Detect nonuniformity when changing concentration	Avoid undesirable reactivity insertion
	Reactor Coolant Loops	pH Measurement	A-L	Detect deviation from specified value	Guide operation to assure effective corrosion control

System	Sample Source	Analysis	Type Sample	Purpose	Application
	Reactor Coolant Loops	Hydrogen Concentration	P-L	Detect deviation from specified value	Guide operation to maintain sufficient hydrogen for oxygen scavenging
	Pressurizer Liquid	Hydrogen Concentration	P-L	Detect explosive mixture when oxygen and hydrogen could be present	Guide operation when venting to atmosphere
	Reactor Coolant Loops	Oxygen Concentration	P-L	Detect concentration above the specified limit	Limit Corrosion
	Reactor Coolant Loops	Conductivity Measurement	A-L	Detect deviations from the specified value	Control to prevent adding detrimental impurities (such as halides)
	Reactor Coolant Loops	Gamma Activity	A-L	Measure gamma of inlet and outlet streams	Indicates general corrosion and fission products
	Reactor Coolant Loops	Total Suspended Solids Content	A-L	Detect solids above specified maximum value	Guide to regulate purification
	Reactor Coolant Loops	Filterable Crud	A-L	Determine isotopic composition of corrosion products	Indicates general corrosion and selective wear

System	Sample Source	Analysis	Type Sample	Purpose	Application
	Pressurizer Relief Tank	Hydrogen Concentration	LP-G	Detect explosive mixture when oxygen and hydrogen could be present	Guide operation to avoid explosion hazard
	Pressurizer Relief Tank	Oxygen Concentration	LP-G	Detect explosive mixture when oxygen and hydrogen could be present	Guide operation to avoid explosion hazard
	Pressurizer Relief Tank	Dissolved Fission Gases	LP-G	Detect accumulation of gross fission gas activity	Guide to venting
Residual Heat Removal	Residual Heat Removal Loop	Boron Concentration	A-L	Determine variance from reactor coolant concentration	Avoid undesirable reactivity insertion
Chemical and Volume Control	Downstream of Demineralizers	Boron Concentration	A-L	Detect deviation from specified value	Monitor concentration
	Downstream of Demineralizers	pH Measurement	A-L	Detect deviation from specified value	Guide operation to assure effective corrosion control
	Volume Control Tank Gas	Hydrogen Concentration	LP-G	Detect explosive mixture when oxygen and hydrogen could be present	Guide operation to avoid explosion hazard

System	Sample Source	Analysis	Type Sample	Purpose	Application
	Volume Control Tank Gas	Oxygen Concentration	LP-G	Detect explosive mixture when oxygen and hydrogen could be present	Guide operation to avoid explosion hazard
	Upstream of Demineralizers	Halides	A-L	Determine Decontamination Factor	Resin performance
	Downstream of Demineralizers	Halides	A-L	Determine Decontamination Factor	Resin performance
	Volume Control Tank	Dissolved Fission Gases	LP-G	Detect accumulation of gross fission gas activity	Guide to venting
	Demineralizer Outlet	Gamma Activity	A-L	Detect concentration	Evaluate resin bed performance
	Upstream of Demineralizers	Gamma Activity	A-L	Determine I-131, I-133 activity	Indicates fuel element failure
	Downstream of Degasifier	Dissolved Fission Gases	A-L	Detect concentration above the specified limit	Guide to operation of degasifier
Steam Generator Condensate Feedwater Main Steam	Sampling and analysis based on EPRI PWR Secondary Water Chemistry Guidelines and Primary to Secondary Leak Rate Guidelines				

System	Sample Source	Analysis	Type Sample	Purpose	Application
B. Post-Accident Sampling:					
Reactor Coolant					
	Reactor Coolant Loops	Total Dose Rate	A-L	Determine dose rate to estimate extent of core damage	Establish remedial action (if any) to be taken
Emergency Core Cooling	Containment Recirculation Sumps	Total Dose Rate	A-L	Determine dose rate to estimate extent of core damage	Establish remedial action (if any) to be taken
Containment	Containment Atmosphere	Hydrogen Concentration	P-G	Estimate extent of core damage and potential for stoichiometric mixture with oxygen	Establish remedial action (if any) to be taken in regard to core, and determine if purging of containment is appropriate
Containment	Containment Atmosphere	Gaseous Radionuclides Concentration	P-G	Determine gamma spectrum to quantify activity levels of constituents	Establish remedial action (if any) to be taken in regard to estimate of core damage, and determine rate and duration for any purging of containment

TABLE 9.3-2 EQUIPMENT DATA - REACTOR COOLANT, STEAM GENERATOR AND AUXILIARY SYSTEMS SAMPLING SUBSYSTEMS

1. ***Sample Heat Exchangers***

Quantity	
Pressurizer	4
Steam Generator	4
Safety Class	NNS
Seismic Category	Nonseismic
Design Code	ASME VIII, Div. I
Design Heat Load	
Pressurizer (1 of 2 in series), Btu/hr	3.7×10^5
Pressurizer (2 of 2 in series), Btu/hr	0.3×10^5
Steam Generator, Btu/hr	2.0×10^5
Shell Side	
PCCW Flow, gpm	8
Temperature In, °F	85
Temperature Out	
Pressurizer (1 of 2 in series), °F	177
Pressurizer (2 of 2 in series), °F	92
Steam Generator, °F	129
Design Temperature, °F	350
Design Pressure, psi	150
Pressure Drop	
Pressurizer (1 of 2 in series), psi	7
Pressurizer (2 of 2 in series), psi	8
Steam Generator, psi	7.3

Tube Side	
Material	316 SS
Diameter, in.	3/8
Sample Flow, gpm	0.75
Temperature In	
Pressurizer (1 of 2 in series), °F	650
Pressurizer (2 of 2 in series), °F	167
Steam Generator, °F	558
Temperature - Out	
Pressurizer (1 of 2 in series), °F	167
Pressurizer (2 of 2 in series), °F	95
Steam Generator, °F	109
Design Temperature, °F	650
Design Pressure, psig	2485
Pressure Drop	
Pressurizer (1 of 2), psi	13.1
Pressurizer (2 of 2), psi	15.3
Steam Generator, psi	13.5

2. Capillary Tubes

Pressurizer Liquid Sample Line	
Tube O.D., in.	0.25
Tube Wall Thickness, in.	0.065
Pressurizer Steam Space Sample Line	
Tube O.D., in.	0.25
Tube Wall Thickness, in.	0.065
Material	Austenitic Stainless Steel
Safety Class	2
Seismic Category	I

Valves, Piping and Tubing

Reactor Coolant Sample Lines	
Design Pressure, psig	2485
Design Temperature, °F	680
O.D., in.	0.375
Wall Thickness, in.	0.065
Steam Generator Blowdown Sample Lines	
Design Pressure, psig	1185
Design Temperature, °F	600
O.D., in.	0.375
Wall Thickness, in.	0.065
Chemical and Volume Control Demineralizers Sample Lines	
Design Pressure, psig	240
Design Temperature, °F	150
O.D., in.	0.375
Wall Thickness, in.	0.065
Volume Control Tank Gas Space	
Design Pressure, psig	75
Design Temperature, °F	150
O.D., in.	0.375
Wall Thickness, in.	0.065
Residual Heat Removal Sample Line	
Design Pressure, psig	600
Design Temperature, °F	400
O.D., in.	0.375
Wall Thickness, in.	0.065

Material	Austenitic Stainless Steel
Design Codes	ANSI B31.1.0, except in-side containment and containment isolation which are designed to ASME III
Safety Class	2 and NNS
Seismic Category	Non-Seismic except inside containment and containment isolation which are seismic Category I

4. Post-Accident Sampling

Flush Tank

Volume, ml	9,600
Design Pressure, psig	2,471
Design Temperature, °F	650
Material	Austenitic Stainless Steel
Design Code	ANSI B31.1.0
Safety Class	NNS
Seismic Category	Non-Seismic

Sample Casks

Size of Cavity, inches	5 I.D. x 51/2 1g.
Wall and End Thickness, inches	3
Shielding Material	Lead

Valves, Piping, and Tubing

Sample Lines	
Design Pressure, psig	2,335
Design Temperature, °F	635
O.D., inches	0.25
Wall Thickness, inches	0.065 and 0.083

Demineralized Water Lines	
Design Pressure, psig	60 and Full Vacuum
Design Temperature, °F	95
O.D., inches	0.375
Wall Thickness, inches	0.049 and 0.065
Material	Austenitic Stainless Steel
Design Code	ANSI B31.1.0
Safety Class	NNS
Seismic Category	Non-Seismic

TABLE 9.3-3 PLANT LEAKAGE SOURCES

a. Containment

1. Sump A

Source	Normal Leak Rate
RC Pump 1A, #3 Seal	3.5 gpd
RC Pump 1B, #3 Seal	3.5 gpd
RC Pump 1C, #3 Seal	3.5 gpd
RC Pump 1D, #3 Seal	3.5 gpd
Six Containment Cooler Drains	Negligible

2. RCDT

RC Pump 1A, #2 Seal	3.0 gph
RC Pump 1B, #2 Seal	3.0 gph
RC Pump 1C, #2 Seal	3.0 gph
RC Pump 1D, #2 Seal	3.0 gph

b. Primary Auxiliary Building

Sample Sink	900 gpd
Containment Enclosure Cooling Units (2)	1 gph, each

c. RHR/CBS Equipment Vaults to Sumps A and B

All Sources	Negligible

d. Fuel Storage Building

Spent Fuel Cask Washdown*	20 gpm
Transfer Cask/Dry Shielded Canister*	20 gpm

* Not actually leakage, but resulting flow during cask washdown

e. Waste Processing Building

Sample Sink (Elev. (-)3'-O")	100 gpd

f. Administration and Service Building RCA Walkways

1. ***Administration and Service Building Sump***

RCA Ship Sump	25 gpd
RCA Locker Room	450 gpd

2. ***Chemical Drain Tank***

Tool Wash Stand	15 gpd
Decontamination Room	26 gpd
Secondary Chem. Lab Sink	100 gpd
Hot Chem. Lab (All Drains)	10 gpd

TABLE 9.3-4 SUMP PARAMETERS*

Bldg	Sump	Tag Number	Capacity (GPM)	TDH	Sump Size	Capacity (gal)[4]	Capacity (gal)[5]
Cont.	A	5A/5B	25	100'	8'x6'x3'[1]	603	111
	B	5C/5D	25	115'	5'x4'x2'	131	81
	TK-55	33A/33B	100	190'	36"x73"[3]	247	102
PAB	A	70A/70B	25	95'	6'x6'x4'	786	134
	TK-118	P-250	25	125'	24"x49"[3]	70	30
RHR/CS	A	71A/71B	25	115'	6'x6'x4'	786	134
Vaults	B	71C/71D	25	115'	6'x6'x4'	786	134
FSB	A	72A/72B	25	90'	4'x4'x4'	350	60
	B	72C/72D	25	90'	4'x4'x4'	350	60
WPB	A	101A/B	50	50'	6'x6'x4'	606	134
	B	101C/D	25	48'	6'x6'x4'	786	134
RCA	A	77A	30	55'	4'x4'x4'[2]	180	120
Walk	B	77B	30	60'	4'x4'x4'[2]	180	120
	C	77C	30	20'	4'x4'x4'[2]	180	120
Admin.	A	230	35	65'	6'x4'x4'	524	105

*Notes:

(1) The sump pumps are mounted on an elevated platform which is 5 feet above the sump bottom. The remainder of the sump top surface is 3 feet above the sump bottom.

(2) The pumps in the RCA walkways are installed in sumps which are 6'-8" deep so the top of the pump motor is below the sump cover plate. The 120 gallon freeboard is based on the four foot height of the sump pump support plate above the sump bottom.

(3) Tank length dimension is for straight shell only, and does not include heads, manway or nozzles.

(4) The sump capacity is the difference in volume between the design low and high levels.

(5) The freeboard capacity is the difference in volume between the high level and a sump overflow condition.

TABLE 9.3-5 CHEMICAL AND VOLUME CONTROL SYSTEM DESIGN PARAMETERS

General

Seal water supply flow rate, for four reactor coolant pumps, nominal (gpm)	32
Seal water return flow rate, for four reactor coolant pumps, nominal (gpm)	12
Letdown flow	
Normal (gpm)	75
Maximum (gpm)	120
Charging flow (excludes seal water)	
Normal (gpm)	55
Maximum (gpm)	100
Temperature of letdown reactor coolant entering system (°F)	560
Temperature of charging flow directed to Reactor Coolant System (°F)	517
Temperature of effluent directed to Boron Recovery System (°F)	115
Centrifugal charging pump miniflow, each (gpm)	60
Maximum pressurization required for preservice hydrostatic testing of Reactor Coolant System (psig)	3107

TABLE 9.3-6 CHEMICAL AND VOLUME CONTROL SYSTEM PRINCIPAL COMPONENT DATA SUMMARY

Positive Displacement Pump

Number	1
Design Pressure (psig)	3200
Design Temperature (°F)	300
Design Flow (gpm)	98
Design Head (ft)	5800
Material	Austenitic Stainless Steel
Maximum Operating Pressure, for Reactor Coolant System Hydrotest Purposes (psig)	3125

Centrifugal Charging Pumps

Number	2
Design Pressure (psig)	2800
Design Temperature (°F)	300
Design Flow (gpm)	150
Design Head (ft)	5800
Material	Austenitic Stainless Steel

Boric Acid Transfer Pump

Number	2
Design Pressure (psig)	150
Design Temperature (°F)	250
Design Flow (gpm)	75
Design Head (ft)	235
Material	Austenitic Stainless Steel

Chiller Pumps

Number	2
Design Pressure (psig)	150
Design Temperature (°F)	200
Design Flow (gpm)	400
Design Head (ft)	150
Material	Carbon Steel

Regenerative Heat Exchanger

Number	1
Heat Transfer Rate at Design Conditions (Btu/hr)	11.0×10^6

Shell Side

Design Pressure (psig)	2485
Design Temperature (°F)	650
Fluid	Borated Reactor Coolant
Material	Austenitic Stainless Steel

Tube Side

Design Pressure (psig)	2735
Design Temperature (°F)	650
Fluid	Borated Reactor Coolant
Material	Austenitic Stainless Steel

Shell Side (Letdown)

Flow (lb./hr)	37,200
Inlet Temperature (°F)	557
Outlet Temperature (°F)	290

Tube Side (Charging)		
Flow (lb./hr)		27,300
Inlet Temperature (°F)		130
Outlet Temperature (°F)		517
Letdown Heat Exchanger		
Number		1
Heat Transfer Rate at Design Conditions (Btu/hr)		16.0×10^6
Shell Side		
Design Pressure (psig)		150
Design Temperature (°F)		250
Fluid		Component Cooling Water
Material		Carbon Steel
Tube Side		
Design Pressure (psig)		600
Design Temperature (°F)		400
Fluid		Borated Reactor Coolant
Material		Austenitic Stainless Steel
Shell Side	Design	Normal
Flow (lb./hr)	498,000	By Mfg.
Inlet Temperature (°F)	95	95
Outlet Temperature (°F)	127	127

Tube Side (Letdown)		
Flow (lb./hr)	59,500	37,200
Inlet Temperature (°F)	380	290
Outlet Temperature (°F)	115	115

Excess Letdown Heat Exchanger

Number		1
Heat Transfer Rate at Design Conditions (Btu/hr)		5.2×10^6
	Shell Side	Tube Side
Design Pressure (psig)	150	2485
Design Temperature (°F)	250	650
Design Flow (lb./hr)	125,000	12,400
Inlet Temperature (°F)	95	557
Outlet Temperature (°F)	137	165
Fluid	Component Cooling Water	Borated Reactor Coolant
Material	Carbon Steel	Austenitic Stainless Steel

Seal Water Heat Exchangers

Number		2
Heat Transfer Rate at Design Conditions (Btu/hr)		$1.6x10^6$
	Shell Side	Tube Side
Design Pressure (psig)	150	150
Design Temperature (°F)	250	250
Design Flow (lb./hr)	125,000	66,000
Inlet Temperature (°F)	95	139
Outlet Temperature (°F)	108	115
Fluid	Component Cooling Water	Borated Reactor Coolant
Material	Carbon Steel	Austenitic Stainless Steel

Moderating Heat Exchange

Number		1
Heat Transfer Rate at Design Conditions (Btu/hr)		$2.53x10^6$
	Shell Side	Tube Side
Design Pressure (psig)	300	300
Design Temperature (°F)	200	200
Design Flow (lb./hr)	59,640	59,640
Design Inlet Temperature, Boron Storage Mode (°F)	50	115
Design Outlet Temperature, Boron Storage Mode (°F)	92.4	72.6
Inlet Temperature, Boron Release Mode (°F)	140	115
Outlet Temperature, Boron Release Mode (°F)	123.7	131.3
Material	Austenitic Stainless Steel	Austenitic Stainless Steel

Letdown Chiller Heat Exchanger

Number		1
Heat Transfer Rate at Design Conditions, Boron Storage Mode (Btu/hr)		1.65×10^6
	Shell Side	Tube Side
Design Pressure (psig)	150	300
Design Temperature (°F)	200	200
Design Flow, Boron Storage Mode (lb./hr)	175,000	59,640
Design Inlet Temperature, Boron Storage Mode (°F)	39	72.6
Design Outlet Temperature, Boron Storage Mode (°F)	48.4	45
Flow, Boron Release Mode (lb./hr)	175,000	59,640
Inlet Temperature, Boron Release Mode (°F)	90	123.7
Outlet Temperature, Boron Release Mode (°F)	99.4	96.1
Material	Carbon Steel	Austenitic Stainless Steel

Letdown Reheat Heat Exchanger

Number		1
Heat Transfer Rate at Design Conditions (Btu/hr)		1.49×10^6
	Shell Side	Tube Side
Design Pressure (psig)	300	600
Design Temperature (°F)	200	400
Design Flow (lb./hr)	59,640	44,730
Inlet Temperature (°F)	115	280
Outlet Temperature (°F)	140	246.7
Material	Austenitic Stainless Steel	Austenitic Stainless Steel

Volume Control Tank

Number	1
Volume (ft^3)	630
Design Pressure (psig)	75
Design Temperature (°F)	250
Material	Austenitic Stainless Steel

Boric Acid Tanks

Number	2
Capacity, Usable (gal)	24,000
Design Pressure	Atmospheric
Design Temperature (°F)	200
Material	Austenitic Stainless Steel

Batching Tank

Number	1
Capacity (gal)	1500
Design Pressure	Atmospheric
Design Temperature (°F)	300
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	Atmospheric
Design Temperature (°F)	200
Material	Carbon Steel

Mixed Bed Demineralizers

Number	2
Design Pressure (psig)	300
Design Temperature (°F)	250
Design Flow (gpm)	120
Resin Volume, each (ft^3)	30 max, 20 min.
Material	Austenitic Stainless Steel

Cation Bed Demineralizers

Number	1
Design Pressure (psig)	300
Design Temperature (°F)	250
Design Flow (gpm)	120
Resin Volume	30
Material	Austenitic Stainless Steel

Thermal Regenerative Demineralizers

Number	5
Design Pressure (psig)	300
Design Temperature (°F)	250
Design Flow (gpm)	200
Resin Volume (ft^3)	74.3
Material	Austenitic Stainless Steel

Demineralizer Pre-Filter

Number	1
Design Pressure (psig)	300
Design Temperature (°F)	250
Design Flow (gpm)	150
Particle Retention	98% of 25 micron size
Material, vessel	Austenitic Stainless Steel

Reactor Coolant Filter

Number	1
Design Pressure (psig)	300
Design Temperature (°F)	250
Design Flow (gpm)	150
Particle Retention	98% of 25 micron size
Material, vessel	Austenitic Stainless Steel

Seal Water Injection Filters

Number	2
Design Pressure (psig)	3100
Design Temperature (°F)	250
Design Flow (gpm)	80
Particle Retention	98% of 5 micron size
Material, vessel	Austenitic Stainless Steel

Seal Water Return Filter

Number	1
Design Pressure (psig)	300
Design Temperature (°F)	250
Design Flow (gpm)	150
Particle Retention	98% of 25 micron size
Material, vessel	Austenitic Stainless Steel

Boric Acid Filter

Number	1
Design Pressure (psig)	300
Design Temperature (°F)	250
Design Flow (gpm)	150
Particle Retention	98% of 25 micron size
Material, vessel	Austenitic Stainless Steel

Chiller Unit

Number	1
Capacity (Btu/hr)	$1.66x10^6$
Design Flow (gpm)	352
Inlet Temperature (°F)	48.4
Outlet Temperature (°F)	39

Letdown Degasifier Component Data

a. Hotwell

Number	1
Design Pressure (psig)	150
Design Temperature (°F)	366
Design Code	ASME Section VIII
Design Flow (lb./hr)	60,000 max., 40,000 norm.
Material	Type 304 SS
Safety Class	NNS

b. Hotwell Heat Exchanger (Installed in Hotwell)

Number		1
Heat Exchange Rate (Btu/hr)		1,155,000
Design Codes		ASME Section VIII, TEMA R
Safety Class		NNS
	Shell Side	Tube Side
Design Temperature (°F)	366	366
Design Pressure (psig)	150	150
Design Flow (lbs./hr)	60,000	1,246
Fluid	Influent	Aux. Steam
Temperature In (°F)	220	353
Temperature Out (°F)	228	325
Material	Type 304 SS	Type 304 SS Tubes, CS Channel

c. Gas After-Cooler (Installed in Column)

Number		1
Heat Exchange Rate (Btu/hr)		84
Design Codes		ASME Section VIII, TEMA R
Safety Class		NNS
	Shell Side	Tube Side
Design Temperature (°F)	366	366
Design Pressure (psig)	150	150
Design Flow	0.4-0.6 scfm	15 gpm
Fluid	Exhaust Gas	Component Cooling Water
Temperature In (°F)	228	85
Temperature Out (°F)	105	91.4
Material	Type 304 SS	Type 304 S

d. Regenerative Heat Exchanger

Number		1
Heat Exchange Rate (Btu/hr)		3,966,000
Design Codes		ASME Section VIII, TEMA R
Safety Class		NNS
	Shell Side	Tube Side
Design Temperature (°F)	250	250
Design Pressure (psig)	150	150
Design Flow (lbs./hr)	55,000	60,000
Fluid	Influent	Effluent
Temperature In (°F)	115	228
Temperature Out (°F)	185	164
Material	Type 304 SS	Type 304 SS

e. Preheater

Number		1
Heat Exchange Rate (Btu/hr)		1,744,999
Design Codes		ASME Section VIII, TEMA R
Safety Class		NNS
	Shell Side	Tube Side
Design Temperature (°F)	366	366
Design Pressure (psig)	150	150
Design Flow (lbs./hr)	1,722	55,000
Fluid	Aux. Steam	Influent
Temperature In (°F)	353	185
Temperature Out (°F)	260	220
Material	CS	Type 304 SS

f. Trim Cooler

Number		1
Heat Exchange Rate (Btu/hr)		2,946,000
Design Codes		ASME Section VIII, TEMA R
Safety Class		NNS
	Shell Side	Tube Side
Design Temperature (°F)	366	366
Design Pressure (psig)	150	150
Design Flow (lbs./hr)	120,000	60,000
Fluid	Primary Component Cooling Water	Effluent
Temperature In (°F)	85	164
Temperature Out (°F)	120	115
Material	CS	Type 304 SS

g. Recirculation Pumps

Number	2
Design Flow (gpm)	120
Design TDH (ft H_20)	240
Material	Type 316 SS
Design Pressure (psig)	150
Design Temperature	250
Motor HP	20
Nominal Speed (rpm)	3600
Design Code	Mfg. Std.
Safety Class	NNS

h. Hydrogen Injector

Number	1
Design Pressure (psig)	150
Design Temperature (°F)	290
Design Flow (gpm)	120
Fluid	Degasifier Effluent
Material	Type 304 SS
Design Code	ASME Section VIII
Safety Class	NNS

i. Static Mixer

Number	1
Design Pressure (psig)	150
Design Temperature (°F)	290
Design Flow (gpm)	120
Fluid	Degasifier Effluent
Material	Type 304 SS
Design Code	ASME Section VIII
Safety Class	NNS

Note: The hydrogen injector and static mixer are not part of the letdown degasifier package, but are integral to the system.

TABLE 9.3-7 FAILURE MODE AND EFFECTS ANALYSIS-CHEMICAL AND VOLUME CONTROL SYSTEM - NORMAL PLANT OPERATION AND SAFE SHUTDOWN

Component	Failure Mode	CVCS Operation Function	*Effect on System Operation and Shutdown	**Failure Detection Method	Remarks
1. Air diaphragm operated globe valve 1-RC-LCV-459 (1-RC-LCV-460 analogous)	a. Fails open	a. Charging and Volume Control – letdown flow	a. Failure reduces redundancy of providing letdown flow isolation to protect PRZ heaters from uncovering at low water level in PRZ. No effect on system operation. Alternate isolation valve (1-RC-LCV-460) provides backup letdown flow isolation.	a. Valve position indication (open) at CB.	a. Valve is designed to fail "closed" and is electrically wired so that the electrical solenoid of the air diaphragm operator is energized to open the valve. Solenoid is de-energized to close the valve upon the generation of a low level PRZ control signal. The valve is electrically interlocked with the letdown modulating control isolation valve (CS-V145) and may not be opened or closed manually from the CB unless valve (CS-V145) is full closed or open respectively.
	b. Fails closed	b. Charging and Volume Control - letdown flow	b. Failure blocks normal letdown flow to VCT. Minimum letdown flow requirements for boration of RCS to safe shutdown concentration level may be met by establishing letdown flow through alternate excess letdown flow path. If the alternate excess letdown flow path to VCT is not available due to common mode failure (loss of instrument air supply) affecting the opening operation of isolation valves in each flow path, the plant operator can borate the RCS to a safe shutdown concentration level without letdown flow by taking advantage of the steam space available in the PRZ.	b. Valve position indication (close) at CB; letdown flow temperature indication (CS-TI-127) at CB; letdown flow-pressure indication (CS-PI-131) at CB; and VCT level indication (CS-LI-112A) and low level alarm at CB.	

* See list at end of table for definition of acronyms and abbreviations used.

** As part of plant operation, periodic tests, surveillance inspections and instrument calibrations are made to monitor equipment and performance. Failures may be detected during such monitoring of equipment in addition to detection methods noted.

Component	Failure Mode	CVCS Operation Function	*Effect on System Operation and Shutdown	**Failure Detection Method	Remarks
2. Motor-operated globe valve CS-HCV-190 (CS-HCV-189 analogous)	a. Fails open	a. Charging and Volume Control - letdown flow	a. Failure reduces redundancy of providing isolation of normal letdown flow through regenerative heat exchanger. No effect on safe shutdown operation. The isolation valve (CS-V145) may be remotely closed from the CB to isolate letdown flow through the heat exchanger.	a. Flow rate indication by CS-FI-132 on MCB-DF.	1. During normal operation valve is manually controlled from the MCB and can be manually adjusted from fully open to fully closed.
	b. Fails closed	b. Charging and Volume Control - letdown flow	b. Failure limits letdown flow to VCT. Minimum letdown flow requirements for boration of RCS to safe shutdown concentration level may be met by opening the alternate letdown modulating control valve (CS-HCV-189). If common mode failure (loss of instrument air) prevents opening of the letdown line and also prevents establishing alternate flow through excess letdown flow path, plant operator can borate the RCS to a safe shutdown concentration level without letdown flow by taking advantage of steam space available in PRZ.	b. Same methods of detection as those stated for item #1, failure mode "Fails closed".	

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Component	Failure Mode	CVCS Operation Function	*Effect on System Operation and Shutdown	**Failure Detection Method	Remarks
3. Air diaphragm operated globe valve CS-V-145	a. Fails open	a. Charging and Volume Control - letdown flow	a. Failure reduces redundancy of providing isolation of normal letdown flow through regenerative heat exchanger. No effect on safe shutdown. The letdown control valves (CS-HCV-189 & 190) may be remotely closed from the CB to isolate letdown flow through the heat exchanger.	a. Valve position indication (open) at CB.	1. Valve is designed to fail "closed" and is electrically wired so that the electrical solenoid of the air diaphragm operator is energized to open the valve. Solenoid is de-energized to close the valve upon the generation of a low level PRZ control signal. The valve is electrically interlocked with valves RC-LCV 459 and 460 and CS-V-149 and 150 so that the valve will automatically close if RC-LCV 459 & 460 and CS-V-149 and 150, are not in the fully open position. Further, the valve may not be manually opened unless CS-V-149 and 150 are opened, and RC-LCV 459 & 460 are opened and pressurizer level is recovered.
	b. Fails closed	b. Charging and Volume Control - letdown flow	b. Same "Effect on system operation and shutdown" as that for item #1, failure mode "Fails closed".	b. Same methods of detection as those stated for item #1 failure mode "Fails closed."	

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Component	Failure Mode	CVCS Operation Function	*Effect on System Operation and Shutdown	**Failure Detection Method	Remarks
4. Motor-operated gate valve CS-V-149. Air diaphragm operated globe valve CS-V-150.	a. Fails closed	a. Charging and Volume Control - letdown flow	a. Same effect on system operation as that stated for item #1, failure mode "Fails closed."	a. Same methods of detection as those stated for item #1, failure mode "Fails closed." In addition, close position group monitoring light at CB.	1. CS-V-149 is a motor-operated gate valve that "fails as is". The valve closes on an ESF "T" signal. 2. CS-V-150 is of similar design as that stated for item #1. Solenoid is de-energized to close the valve upon the generation of an ESF "T" signal.
	b. Fails open	b. Charging and Volume Control - letdown flow	b. Failure has no effect on CVCS operation during normal plant operation. However, under accident conditions requiring containment isolation, failure reduces the redundancy of providing isolation of normal letdown line.	b. Valve position indication (open) at CB.	

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Component	Failure Mode	CVCS Operation Function	*Effect on System Operation and Shutdown	**Failure Detection Method	Remarks
5. Air diaphragm operated globe valve 1-CS-TCV-381B	a. Fails open	a. Boron Concentration Control - boron thermal regeneration (boration)	a. Failure prevents use of BTRS for load follow operation (boration) due to low temperature of letdown flow entering BTRS demineralizers. Alternate boration of reactor coolant for load follow is possible using RMCS of CVCS. No effect on operations to bring reactor to safe shutdown condition.	a. BTR demineralizer inlet flow temperature indication (CS-TI-381) at CB.	1. Valve is designed to fail "open" and is electrically wired so that the electrical solenoid of the air diaphragm operator is energized to close the valve. 2. BTRS operation is not required in operations of CVCS systems used to bring the reactor to a safe shutdown condition.
	b. Fails closed	b. Boron Concentration Control - boron thermal regeneration (boration)	b. Failure prevents use of BTRS for load follow operation (boration) due to loss of temperature control of letdown flow entering BTRS demineralizers. Failure also blocks normal letdown flow to VCT when BTRS is not being used for load follow. Minimum letdown flow requirements for boration of RCS to a safe shutdown concentration level may be met as stated for effect on system operation for item #1, failure mode "Fails closed"	b. Same method of detection as those stated for item #1, failure mode "Fails closed" except no "close" position indication at CB.	

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Component	Failure Mode	CVCS Operation Function	*Effect on System Operation and Shutdown	**Failure Detection Method	Remarks
6. Air diaphragm operated globe valve 1-CS-PCV-131	a. Fails open	a. Charging and Volume Control - letdown flow	a. Failure prevents control of pressure to prevent flashing of letdown flow in letdown heat exchanger and also allows high pressure fluid to mixed bed demineralizers. Relief valve (CS-V329) opens in demineralizer line to release pressure to VCT and valve (CS-TCV-129) changes position to divert flow to VCT. Boration of RCS to safe shutdown concentration level is possible with valve failing open.	a. Letdown heat exchanger tube discharge flow indication (CS-FI-132) and high flow alarm at CB; temperature indication (CS-TI-130) and high temperature alarm at CB; and pressure indication (CS-PI-131) at CB.	1. Same remark as stated for item #5 in regards to valve design.
	b. Fails closed	b. Charging and Volume Control - letdown flow	b. Same effect on system operation as that for item #1, failure mode "Fail closed."	b. Letdown heat exchanger discharge flow indication (CS-FI-132), and pressure indication (CS-PI-131) and high pressure alarm at CB.	

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Component	Failure Mode	CVCS Operation Function	*Effect on System Operation and Shutdown	**Failure Detection Method	Remarks
7. Air diaphragm operated three way valve 1-CS-TCV-129	a. Fails open for flow only to VCT.	a. Charging and Volume Control - letdown flow	a. Letdown flow bypassed from flowing to mixed bed demineralizers and BTRS. Failure prevents ionic purification of letdown flow and prevents operation of BTRS. Boration of RCS to safe shutdown concentration level is possible with valve failing open for flow only to VCT.	a. Valve position indication (VC Tank) at CB.	1. Electrical solenoid of air diaphragm operator is electrically wired so that solenoid is energized to open valve for flow to the mixed bed demineralizers.
	b. Fails open for flow only to mixed bed demineralizer.	b. Charging and Volume Control - letdown flow	b. Continuous letdown to mixed bed demineralizers and BTRS. Failure prevents automatic isolation of mixed bed demineralizers and BTRS under condition of high letdown flow temperatures. Boration of RCS to safe shutdown concentration level is possible with valve failing open for flow only to demineralizer.	b. Valve position indication (Demin.) at CB. If BTRS is in operation, BTR demineralizer return flow indication (CS-FI-385).	
8. Air diaphragm operated globe valve CS-V175 (CS-V-176 analogous).	a. Fails closed	a. Charging and Volume Control - letdown flow	a. Failure prevents use of the Excess Letdown System of the CVCS as an alternate system that may be used for letdown flow control during normal plant operation. If normal letdown and excess letdown flow is not available for safe shutdown operations, plant operator can borate RCS to safe shutdown concentration using steam space available in PRZ.	a. Valve position indication (closed) at CB and excess letdown heat exchanger outlet pressure indication (CS-PI-124) and temperature indication (CS-TI-122) at CB.	1. Valve is designed to fail "closed" and is electrically wired so that the electrical solenoid of air diaphragm operator is energized to open the valve
	b. Fails open	b. Charging and Volume Control - letdown flow	b. Failure reduces redundancy of providing excess letdown flow isolation during normal plant operation and for startup. No effect on system operation. Alternate isolation valve (CS-V176) can be closed to provide backup flow isolation of excess letdown line.	b. Valve position indication (open) at CB.	

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Component	Failure Mode	CVCS Operation Function	*Effect on System Operation and Shutdown	**Failure Detection Method	Remarks
9. Air diaphragm operated globe valve 1-CS-HCV-123	a. Fails closed	a. Charging and Volume Control - letdown flow	a. Same effect on system operation as stated for item #8, failure mode "Fails closed."	a. Same methods of detection as those stated for item #8, failure mode "Fails closed," except no valve position indication at CB.	1. Same remark as that stated above for item #8.
	b. Fails open	b. Charging and Volume Control - letdown flow	b. Failure prevents manual adjustment at CB of RCS system pressure downstream of excess letdown heat exchanger to a low pressure requirements. Relief valve CS-V173 opens in seal return line to release pressure to PRT.	b. Excess letdown heat exchanger outlet pressure indication (CS-PI-124) and temperature indication (CS-TI-122) at CB.	
10. Air diaphragm operated diaphragm valve 1-RC-LCV-181 (1-RC-LCV-180 analogous)	a. Fails closed	a. Charging and Volume Control - seal water flow	a. No makeup of seal water to seal standpipe that services No. 3 seal of RC pump #1. No effect on operation to bring the plant to a safe shutdown condition.	a. Valve position indication (open to closed position change) and low standpipe level alarm at CB.	1. Same remark as that stated for item #8 in regard to valve design. 2. Low level standpipe alarm conservatively set to allow additional time for RC pump operation with out a complete loss of seal water form being injected to No. 3 seal after sounding of alarm.
	b. Fails open	b. Charging and Volume Control - seal water flow	b. Overfill of seal water standpipe and dumping of reactor makeup water to containment sump during makeup of water for No. 3 seal of RC pump #1. No effect on operations to bring reactor to a safe shutdown condition.	b. Valve position indication (closed to open position change) and high standpipe level alarm at CB.	

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Component	Failure Mode	CVCS Operation Function	*Effect on System Operation and Shutdown	**Failure Detection Method	Remarks
11. Motor-operated globe valve CS-V168 (CS-V167 analogous)	a. Fails open	a. Charging and Volume Control - seal water flow and excess letdown flow	a. Failure has no effect on CVCS operation during normal plant operation. However, under accident conditions requiring containment isolation failure reduces redundancy of providing isolation of seal water flow and excess letdown flow.	a. Valve position indication (closed to open position change) at CB.	1. Valve is normally at a full open position and motor operator is energized to close the valve upon the generation of an ESF "T" signal.
	b. Fails closed	b. Charging and Volume Control - seal water flow and excess letdown flow	b. RC pump seal water return flow and excess letdown flow blocked. Failure inhibits use of the Excess Letdown System of the CVCS as an alternate system that may be used for letdown flow control during normal plant operation and degrades cooling capability of seal water in cooling RC pump bearings.	b. Valve position indication (open to close position change) at CB; group monitoring light and alarm at CB; and seal water return flow recording (CS-FR-157) and low seal water return flow alarm at CB.	
12. Motor-operated gate valve CS-V143 (CS-V142 analogous)	a. Fails open	a. Charging and Volume Control - charging flow	a. Failure has no effect on CVCS operation during normal plant operation. However, under accident condition requiring isolation of charging line, failure reduces redundancy of providing isolation of normal charging flow.	a. Valve position indication (closed to open position change) at CB.	1. Valve is normally at a full open position and motor operator is energized to close the valve upon the generation of a Safety Injection "S" signal.
	b. Fails closed	b. Charging and Volume Control - charging flow	b. Failure prevents use of normal charging line to RCS for boration, dilution, and coolant makeup operations. Seal water injection path remains available for boration of RCS to a safe shutdown concentration level and makeup of coolant during operations to bring the reactor to a safe shutdown condition.	b. Valve position indication (open to closed position change) and group monitoring light (valve closed) to CB; letdown temperature indication (CS-TI-127) and high temperature alarm at CB; charging flow temperature indication (CS-TI-126) at CB; seal water flow pressure indication (CS-PI-120A) at CB; VCT level indication (CS-LI-112A) and (CS-LI-185) and high level alarm at CB.	

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Component	Failure Mode	CVCS Operation Function	*Effect on System Operation and Shutdown	**Failure Detection Method	Remarks
13. Air diaphragm operated globe valve 1-CS-HCV-182	a. Fails open	a. Charging and Volume Control - charging flow and seal water flow	a. Failure prevents manual adjustment at CB of seal water flow through the control of back pressure in charging header resulting in a reduction of flow to RC pump seals leading to a reduction in flow to RCS via labyrinth seals and pump shaft flow for cooling pump bearings. Boration of RCS to a safe shutdown concentration level and makeup of coolant during operations to bring reactor to a safe shutdown condition is still possible through normal charging flow path.	a. Seal water flow pressure indication (CS-PI-120A) at CB; seal water return recording (CS-FR-157); and low seal water return flow alarm at CB.	1. Same remark as that stated for item #5 in regard to design of valve.
	b. Fails closed	b. Charging and Volume Control - charging flow	b. Same effect on system operation as that stated for item #12, failure mode "Fails closed."	b. Same method of detection as those stated above for item #12, failure mode "Fails closed."	
14. Motor-operated globe valve CS-V196 (CS-V197 analogous)	a. Fails open	a. Charging and Volume Control - charging flow and seal water flow	a. Failure has no effect on CVCS operation during normal plant operation. However, under accident condition requiring isolation of centrifugal charging pump miniflow line, failure reduces redundancy of providing isolation of miniflow to suction of pumps via seal water heat exchanger.	a. Valve position indication (closed to open position change) at CB.	1. Same remark as that stated for item #12.
	b. Fails closed	b. Charging and Volume Control - charging flow and seal water flow	b. Failure blocks miniflow to suction of centrifugal charging pumps via seal water heat exchanger. Normal charging flow and seal water flow prevents deadheading of pumps when used. Boration of RCS to a safe shutdown concentration level and makeup of coolant during operations to bring reactor to a safe shutdown condition is still possible.	b. Valve position indication (open to closed position change) at CB; group monitoring light (valve closed) and alarm at CB; and charging and seal water flow indication (CS-FI-121A) and high Flow alarm at CB.	

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Component	Failure Mode	CVCS Operation Function	*Effect on System Operation and Shutdown	**Failure Detection Method	Remarks
15. Air diaphragm operated globe valve CS-V180 (CS-V177 analogous)	a. Fails open	a. Charging and Volume Control - charging flow	a. Failure has no effect on CVCS operation during normal plant operation and safe shutdown operation. Valve is used during cold shutdown operation to isolate normal charging line when using the auxiliary spray during the cooldown of the pressurizer. Cold shutdown of reactor is still possible, however, time for cooling down PRZ will be extended.	a. Valve position indication (closed to open position change) at CB.	1. Same remark as that stated for item #5 in regards to design of valve.
	b. Fails closed	b. Charging and Volume Control - charging flow	b. Failure blocks normal charging flow to the RCS. No effect on CVCS operations during normal plant operation or safe shutdown operation. Plant operator can maintain charging flow by establishing flow through alternate charging path by opening of isolation valve (CS-V177).	b. Valve position indication (open to closed position change) at CB; charging flow temperature indication (CS-TI-126) at CB; regenerative heat exchanger shell side exit temperature indication (CS-TI-127) and high temperature alarm at CB; and charging and seal water flow indication (CS-FI-121A) and low flow alarm at CB.	
16. Air diaphragm operated globe valve CS-V185	a. Fails open	a. Charging and Volume Control - charging flow	a. Failure results in inadvertent operation of auxiliary spray that results in a reduction of PRZ pressure during normal plant operation. PRZ heaters operate to maintain required PRZ pressure. Boration of RCS to a safe shutdown concentration level and makeup of coolant during operation to bring reactor to a safe shutdown condition is still possible.	a. Valve position indication (closed to open position change) at CB and PRZ pressure recording (RC-PR-455) and low pressure alarm at CB.	1. Same remark as that stated for item #8 in regards to design of valve.
	b. Fails closed	b. Charging and Volume Control - charging flow	b. Failure has no effect on CVCS operation during normal plant operation and safe shutdown operation. Valve is used during cold shutdown operation to activate auxiliary spray for cooling down the pressurizer after operation of RHRS.	b. Valve position indication (open to closed position change) at CB.	

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Component	Failure Mode	CVCS Operation Function	*Effect on System Operation and Shutdown	**Failure Detection Method	Remarks
17. Air diaphragm operated globe valve 1-CS-FCV-121	a. Fails open	a. Charging and Volume Control - charging flow and seal water flow	a. Failure reduces redundancy of providing charging and seal water flow to RCS. No effect on normal plant operation or bringing reactor to a safe shut condition. Constant displacement pump may be used for delivery of charging and seal water flow to RCS. Check valves (CS-V200 and CS-V209) provide isolation of constant displacement pump flow to discharge of centrifugal charging pump if valve fails "open" during operation of constant displacement pump.	a. Charging and seal water flow indication (CS-FI-121A) and high flow alarm at CB, and PRZ level recording (RC-LR-459) and high level alarm at CB.	1. Same remark as that stated for item #5 in regards to design of valve. 2. Methods of detection apply when a centrifugal charging pump is in operation.
	b. Fails closed	b. Charging and Volume Control - charging flow and seal water flow	b. Failure reduces redundancy of providing charging and seal water flow to RCS. No effect on system operation during normal plant operation or bringing reactor to a safe shutdown condition. Constant displacement pump may be used for delivery of charging and seal water flow to RCS. No effect of valve failing closed under an accident condition requiring flow delivery by centrifugal charging pumps.	b. Charging and seal water flow indication (CS-FI-121A and low flow alarm at CB, and PRZ level recording (RC-LR-459) and low level alarm at CB.	
18. Constant displacement pump CS-P-128	a. Fails to deliver working fluid.	a. Charging and Volume Control - charging flow and seal water flow	a. Failure reduces redundancy of providing charging and seal water flow to RCS. No effect on normal plant operation or bringing reactor to a safe shutdown condition. Centrifugal charging pump (CS-P-2A or CS-P-2B) may be placed into operation for delivery of charging and seal water flow.	a. Pump circuit breaker position indication (open) at CB; common pump breaker trip alarm at CB; charging and seal water flow indication (CS-FI-121A) and low flow alarm at CB; and PRZ level recording (RC-LR-459) and low level alarm at CB.	1. Pump speed is regulated to control amount of charging flow delivered to the PRZ.

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Component	Failure Mode	CVCS Operation Function	*Effect on System Operation and Shutdown	**Failure Detection Method	Remarks
19. Centrifugal charging pump CS-P-2A (CS-P-2B analogous)	a. Fails to deliver working fluid.	a. Charging and Volume Control - charging flow and seal water flow	a. Failure reduces redundancy of providing charging and seal water flow to RCS. Delivery of charging and seal water flow by alternate centrifugal charging pump available. No effect on normal plant operation or bringing reactor to a safe shutdown condition. Constant displacement pump also used for delivery of charging and seal water flow.	a. Same methods of detection as those stated above for item #18 when centrifugal charging pump CS-P-2A is in operation.	1. Flow rate for a centrifugal charging pump is controlled by a modulating valve (1-CS-FCV-121) in discharge header for the centrifugal charging pumps.
20. Air diaphragm operated globe valve CS-PCV-8156	a. Fails closed	a. Chemical Control, Purification and Makeup - oxygen control	Failure blocks hydrogen flow to VCT and leads to loss of venting of VCT resulting in loss of gas stripping of fission products from RCS coolant. No effect on operation to bring the reactor to a safe shutdown condition.	a. VCT pressure indication (CS-PI-115A) and low pressure alarm at CB.	1. Valve is designed to fail "closed."
21. Motor-operated gate valve 1-CS-LCV-112B (1-CS-LCV-112C analogous)	a. Fails open	a. Charging and Volume Control - charging flow and seal water flow	a. Failure has no effect on CVCS operation during normal plant operation and bringing reactor to a safe shutdown condition. However, under accident conditions requiring isolation of VCT, failure reduces redundancy of providing isolation for discharge line of VCT.	a. Valve position indication (closed to open position change) at CB.	1. During normal plant operation valve is at a full open position and the motor operator is energized to close the valve upon the generation of a VCT low-low level signal or upon the generation of a Safety Injection "S" signal.
	b. Fails closed	b. Charging and Volume Control - charging flow and seal water flow	b. Failure blocks fluid flow from VCT during normal plant operation and when bringing the reactor to a safe shutdown condition. Alternate supply of borated (2,000 ppm) coolant form the RWST to suction of charging pumps can be established from the CB by the operator through the opening of RWST isolation valves (1-CS-LCV-112D and 1-CS-LCV-112E).	b. Valve position indication (open to closed position change) at CB; group monitoring light (valve closed) at CB; charging and seal water flow indication (CS-FI-121A) and low flow alarm at CB; and PRZ level recording (RC-LR-459) and low level alarm at CB.	

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Component	Failure Mode	CVCS Operation Function	*Effect on System Operation and Shutdown	**Failure Detection Method	Remarks
22. Air diaphragm operated diaphragm valve 1-CS-FCV-110B	a. Fails closed	a. Boron Concentration Control – reactor makeup control – boration, auto makeup, and alternate dilution.	a. Failure blocks fluid flow from Reactor Makeup Control System for automatic boric acid addition and reactor water makeup during normal plant operation. Failure also reduces redundancy of fluid flow paths for dilution of RCS coolant by reactor makeup water and blocks fluid flow for boration of the RCS coolant when bringing the reactor to a safe shutdown condition. Boration (at BA tank boron concentration level) of RCS coolant to bring the reactor to a safe shutdown condition is possible by opening of alternate BA tank isolation valve (CS-V426) at CB.	a. Valve position indication (open to closed position change) at CB; total makeup flow deviation alarm at CB; and VCT level indications (CS-LI-112A and CS-LI-185) and low level alarms (low and low-low) at CB.	1. Same remark as that stated for item #8 in regards to valve design.
	b. Fails open	b. Boron Concentration Control – reactor makeup control – boration, auto makeup, and alternate dilution.	b. Failure allows for alternate dilute mode type operation for system operation of normal dilution of RCS coolant. No effect on CVCS operation during normal plant operation and when bringing the reactor to a safe shutdown condition.	b. Valve position indication (closed to open change) at CB.	

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Component	Failure Mode	CVCS Operation Function	*Effect on System Operation and Shutdown	**Failure Detection Method	Remarks
23. Air diaphragm operated diaphragm valve 1-CS-FCV-111B	a. Fails closed	a. Boron Concentration Control - reactor makeup control - dilution and alternate dilution	a. Failure blocks fluid flow from RMCS for dilution of RCS coolant during normal plant operation. No effect on CVCS operation. Operator can dilute RCS coolant by establishing "alternate dilute" mode of system operation. Dilution of RCS coolant not required when bringing the reactor to a safe shutdown condition.	a. Same methods of detection as those stated above for item #22, failure mode "Fails closed."	1. Same remark as that stated for item #8 in regard to valve design.
	b. Fails open	b. Boron Concentration Control - reactor makeup control - dilution and alternate dilution	b. Failure allows for dilute mode type operation for system operation of boration and auto makeup of RCS coolant. No effect on CVCS operation during normal plant operation and load follow and when bringing the reactor to a safe shutdown condition.	b. Valve position indication (closed to open position change) at CB.	

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Component	Failure Mode	CVCS Operation Function	*Effect on System Operation and Shutdown	**Failure Detection Method	Remarks
24. Air diaphragm operated globe valve 1-CS-FCV-110A	a. Fails open	a. Boron Concentration Control - reactor makeup control - boration, and auto makeup	a. Failure prevents the addition of a pre-selected quantity of concentrated boric acid solution at a pre-selected flow rate to the RCS coolant during normal plant operation and when bringing the reactor to a safe shutdown condition. Boration to bring the reactor to a safe shutdown condition is possible, however, flow rate of solution form BA tanks can not be automatically controlled.	a. Boric acid flow recording (on MPCS) and flow deviation alarm at CB. Valve position indicating lights at CB.	1. Same remark as that stated for item #5 in regard to valve design.
	b. Fails closed	b. Boron Concentration Control - reactor makeup control - boration, and auto makeup	b. Failure blocks fluid flow of boric acid solution from BA tanks during normal plant operation and when bringing the reactor to a safe shutdown condition. Boration (at BA tank boron concentration level) of RCS coolant to bring the reactor to a safe shutdown condition is possible by opening of alternate BA tank isolation valve (CS-V426) at CB.	b. Boric acid flow recording (on MPCS) and flow deviation alarm at CB. Valve position indicating lights at CB.	
25. Air diaphragm operated globe valve 1-CS-FCV-111A	a. Fails closed	a. Boron Concentration Control - reactor makeup control - dilute, alternate dilute and auto makeup	a. Failure blocks fluid flow of water from Reactor Makeup Control System during normal plant operation. No effect on system operation when bringing the reactor to a safe shut condition.	a. VCT level indications (CS-LI-112A and CS-LI-185) and low level alarms (low and low-low) at CB; and makeup water flow recording (on MPCS) and flow deviation alarm at CB. Valve position indicating lights at CB.	1. Same remark as that stated for item #8 in regard to valve design.
	b. Fails open	b. Boron Concentration Control – reactor makeup control – dilute, alternate dilute and auto makeup	b. Failure prevents the addition of a preselected quantity of water makeup at a pre-selected flow rated to the RCS coolant during normal plant operation. No effect on system operation when bringing the reactor to a safe shutdown condition.	b. Makeup water flow recording (on MPCS) and flow deviation alarm at CB. Valve position indicating lights at CB.	

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Component	Failure Mode	CVCS Operation Function	*Effect on System Operation and Shutdown	**Failure Detection Method	Remarks
26. Motor-operated globe valve CS-V426	a. Fails closed	a. Boron Concentration Control - reactor makeup control - boration, and auto makeup	a. Failure reduces redundancy of flow paths for supplying boric acid solution form BA tanks to RCS via charging pumps. No effect on CVCS operation during normal plant operation or safe shutdown operation. Normal flow path via RMCS and gravity feed line remains available for boration of RCS coolant.	a. Valve position indication (open to closed position change) at CB and flow indication (CS-FI-183A) at CB.	1. Valve is at a closed position during normal RMCS operation. 2. If both flow paths from BA tanks are blocked due to failure of isolation valves (1-CS-FCV-110A and CS-V426), borated water from BAT via gravity feed line or borated water (2400-2600 ppm) from RWST is available by opening isolation valve 1-CS-LCV-112D or 1-CS-LCV-112E.
	b. Fails open	b. Boron Concentration Control - reactor makeup control - boration, and auto makeup	b. Failure prevents the addition of a pre-selected quantity of concentrated boric acid solution at a pre-selected flow rate to the RCS coolant during normal plant operation and when bringing the reactor to a safe shutdown condition. Boration to bring the reactor to a safe shutdown condition is possible; however, flow rate of solution form BA tanks can not be automatically controlled.	b. Valve position indication (closed to open position change) at CB and flow indication (CS-FI-183A) at CB.	

* See list at end of table for definition of acronyms and abbreviations used.

** As part of plant operation, periodic tests, surveillance inspections and instrument calibrations are made to monitor equipment and performance. Failures may be detected during such monitoring of equipment in addition to detection methods noted.

Component	Failure Mode	CVCS Operation Function	*Effect on System Operation and Shutdown	**Failure Detection Method	Remarks
27. Boric acid transfer pump CS-P-3A (BA transfer pump CS-P-3B analogous)	a. Fails to deliver working fluid.	a. Boron Concentration Control - reactor makeup control - boration and auto makeup.	a. No effect on CVCS system operation during normal plant operation or bringing reactor to a safe shutdown condition. Redundant BA transfer pump CS-P-3B provides necessary delivery of working fluid for CVCS system operation.	a. Pump motor start relay position indication (open) at CB and local pump discharge pressure indication (CS-PI-113).	1. Both BA transfer pumps operate simultaneously for RMCS boration operation.

List of acronyms and abbreviations

BA	- Boric Acid
BRS	- Boron Recovery System
BTR	- Boron Thermal Regeneration System
BTRS	- Boron Thermal Regeneration System
CB	- Control Board
CVCS	- Chemical and Volume Control System
Demin.	- Demineralizer
PRZ	- Pressurizer
RC	- Reactor Coolant

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* See list at end of table for definition of acronyms and abbreviations used.

** As part of plant operation, periodic tests, surveillance inspections and instrument calibrations are made to monitor equipment and performance. Failures may be detected during such monitoring of equipment in addition to detection methods noted.

TABLE 9.3-8 BORON RECOVERY SYSTEM COMPONENTS

Primary Drains Tank Transfer Pumps

Quantity	2
Design Pressure, psig	150
Design Temperature, °F	200
Design Flow, gpm	120
Design TDH, ft	220
Material	316SS
Code Design	Mfg. Standard

Degasifier Recirculation Pump

Quantity	2
Design Pressure, psig	150
Design Temperature, °F	250
Design Flow, gpm	120
Design TDH, ft	240
Material	316SS
Design Code	Mfg. Standard

Recovery Evaporator Feed Pumps

Quantity	2
Design Pressure, psig	150
Design Temperature, °F	200
Design Flow, gpm	40
Design Head, ft	130
Material	316SS
Code Design	Mfg. Standard

Recovery Evaporator Reboiler Pump

Quantity	2
Design Pressure, psig	150
Design Temperature, °F	300
Design Flow, gpm	12,000
Design Head, ft	20
Material	Alloy 20 Cb-3
Code Design	Mfg. Standard

Recovery Evaporator Bottoms Pump

Quantity	2
Design Pressure, psig	150
Design Temperature, °F	300
Design Flow, gpm	15
Design Head, ft	120
Material	Goulds Alloy 20
Code Design	Mfg. Standard

Recovery Distillate Pump

Quantity	2
Design Pressure, psig	150
Design Temperature, °F	300
Design Flow, gpm	30
Design Head, ft	120
Material	316SS
Code Design	Mfg. Standard

Recovery Test Tank Pumps

Quantity	2
Design Pressure, psig	150
Design Temperature, °F	200
Design Flow, gpm	200
Design Head, ft	190
Material	316SS
Code Design	Mfg. Standard

Primary Drain Tank

Quantity	2
Volume, gal	8600
Design Pressure, psig	15
Design Temperature, °F	200
Type	Vertical
Material	304SS
Code Design	ASME VIII

Boron Waste Storage Tanks

Quantity	2
Volume, gal. (ea)	225,000
Design Pressure, psig	1.0
Design Temperature, °F	200
Material	304SS
Code Design	API-620

Recovery Test Tanks

Quantity	2
Volume, gal. (ea)	18,000
Design Pressure, psig	Atmospheric
Design Temperature, °F	200
Material	304SS
Diaphragm	Yes
Code Design	ASME VIII

Recovery Evaporator Distillate Accumulator

Quantity	2
Volume, gal.	300
Design Pressure, psig	Full vacuum to 50 psig
Design Temperature, °F	300
Material	304SS
Code Design	ASME VIII

Primary Drain Tank Degasifier Prefilter

Quantity	1
Design Pressure, psig	150
Design Temperature, °F	200
Design Flow, gpm	120
Retention for 5 Micron Particles	98%
Material	304SS
Design Code	ASME VIII

Recovery Filters

Quantity	2
Design Pressure, psig	150
Design Temperature, °F	300
Design Flow, gpm	200 (300 upset)
Retention for 25 Micron Particles	98%
Material, vessel	304SS
Code Design	ASME VIII

Recovery Evaporator Bottoms Filter

Quantity	2
Design Pressure, psig	150
Design Temperature, °F	300
Design Flow, gpm	50
Retention of 25 Micron Particles	98%
Material, vessel	304SS
Code Design	ASME VIII

Recovery Demineralizer Filter

Quantity	2
Design Pressure, psig	150
Design Temperature, °F	200
Design Flow, gpm	250
Retention for 25 Micron Particles	98%
Material, vessel	304SS
Code Design	ASME VIII

Recovery Demineralizer

Quantity	2
Design Pressure, psig	150
Design Temperature, °F	300
Media Volume, ft^3	75
Design Flow, gpm	240
Material	304SS
Code Design	ASME VIII

Primary Drain Tank Demineralizer Vessel

Quantity	2
Design Pressure, psig	150
Design Temperature, °F	300
Media Volume, ft^3	75
Design Flow, gpm	240
Material	304SS
Code Design	ASME VIII

Primary Drain Tank Degasifier

Quantity	1
Design Flow, gpm	120
Design Pressure, psig	150
Design Temperature, °F	366
Design Code	ASME VIII
Material	304SS

Hotwell Heat Exchanger (Integral to Degasifier)

Heat Exchange Rate, Btu/hr	1,155,000	
Design Codes	ASME VIII	TEMA R
	Shell Side	Tube Side
Design Temperature, °F	366	366
Design Pressure, psig	150	150
Design Flow, lb./hr	60,000	1486
Fluid	Influent	Auxiliary Steam
Temperature In, °F	220	353
Temperature Out, °F	228	325
Material	304SS	304SS (with C.S. channel)

Column After-Gas Cooler (Integral to Degasifier)

Heat Exchange Rate, Btu/hr	84	
Design Code	ASME VIII	TEMA R
	Shell Side	Tube Side
Design Temperature, °F	366	150
Design Pressure, psig	150	200
Design Flow	0.4-0.6 SCFM	7,500 lb./hr
Fluid	Exh. Gases	PCCW
Temperature In, °F	228	85
Temperature Out, °F	105	85 to 86
Material	304SS	304SS

Degasifier Regenerative Heat Exchanger

Quantity	1	
Heat Exchange Rate, Btu/hr	3,966,000	
Design Code	ASME VIII	TEMA R
	Shell Side	Tube Side
Design Temperature, °F	250	250
Design Pressure, psig	300	300
Design Flow, lb./hr	55,000	60,000
Fluid	Influent	Effluent
Temperature In, °F	115	228
Temperature Out, °F	185	164
Material	304SS	304SS

Degasifier Preheater

Quantity	1	
Heat Exchange Rate, Btu/hr	1,744,999	
Design Code	ASME VIII	TEMA R
	Shell Side	Tube Side
Design Temperature, °F	366	250
Design Pressure, psig	150	300
Design Flow, lb./hr	1722	55,000
Fluid	Aux. Steam	Influent
Temperature In, °F	353	185
Temperature Out, °F	260	220
Material	Carbon Steel	304SS

Degasifier Trim Cooler

Quantity	1	
Heat Exchange Rate, Btu/hr	2,946,000	
Design Code	ASME VIII	TEMA R
	Shell Side	Tube Side
Design Temperature, °F	366	366
Design Pressure, psig	150	150
Design Flow, lb./hr	120,000	60,000
Fluid	PCCW	Effluent
Temperature In, °F	85	164
Temperature Out, °F	126	115
Material	Carbon Steel	304SS

Recovery Evaporator

Number	2	
Design Pressure, psig	50 to full vacuum	
Design Temperature, °F	300	
Design Flow, gpm	25	
Material	316SS (upper);	Incoloy 825 (lower)
Code Design	ASME VIII	

<u>Recovery Evaporator Distillate Cooler</u>

Number	2	
	<u>Tube Side</u>	<u>Shell Side</u>
Capacity	12,504 lbs./hr	164 gpm
Design Pressure, psig	150	150
Design Temperature, °F	300	200
Fluid	Distillate	Cooling Water
Temperature In, °F	250	85
Temperature Out, °F	120	105
Material	304SS	CS
Code Design	ASME VIII, TEMA C	

<u>Recovery Evaporator Reboiler</u> (Heating Element)

Number	2	
	<u>Shell Side</u>	<u>Tube Side</u>
Capacity	19,074 lbs./hr	12,000 gpm
Design Pressure, psig	150 full vacuum	150 full vacuum
Design Temperature, °F	375	300
Fluid	Steam/Condensate	Process
Temperature In, °F	353	252
Temperature Out, °F	353	255
Material	CB	Incoloy 825
Code Design	ASME VIII, TEMA C	

Recovery Evaporator Distillate Condenser

Number	2	
	Shell Side	Tube Side
Capacity	14,886 lbs./hr	959 gpm
Design Pressure, psig	150	150
Design Temperature, °F	300	200
Fluid	Distillate,vapor	Cooling Water
Temperature In, °F	250	85
Temperature Out, °F	250	115
Material	304SS	CS
Code Design	ASME VIII, TEMA C	

Recovery Evaporator Bottoms Cooler

Number	2	
	Shell Side	Tube Side
Capacity, gpm	66.8	15
Design Pressure, psig	150	150
Design Temperature, °F	200	300
Fluid	Cooling Water	Process
Temperature In, °F	85	252
Temperature Out, °F	105	150
Material	CS	Incoloy 825
Code Design	ASME VIII	

Piping and Valves

Material	304 and 316 SS
Design Code	B-31.1

TABLE 9.3-9 BORON RECOVERY SYSTEM MALFUNCTION ANALYSIS

Component	Malfunction	Comments and Consequences
Pressure vessels and other components containing letdown liquids with dissolved gases	Outleakage	Primary drain tanks, degasifier, and evaporators along with their associated piping are protected from overpressure by automatic controls and safety relief valves. Only minor leaks are considered possible. For example, the degasifier safety valves are expected to actuate once a year releasing 0.3 millicuries assuming a 0.2% fuel cladding defect.
Boron waste storage tanks	Outleakage	Only degassed liquids are normally stored in these tanks which are protected by dikes capable of the tanks. The dikes are seismic Category I structures.
Recovery evaporators or auxiliaries	Failure to function	Sufficient capability to make boric acid solution for station requirements exist in the boric acid batch tanks. The Demineralized Water Makeup System (Subsection 9.2.3) can supply adequate quantities of primary grade water.
Tanks and piping	Rupture	The safety relief valves on the pressurized systems are set at pressures below the design pressures considering reasonable transients in the system. In spite of this, should a rupture occur, safety- related structures and equipment will not be flooded. Proper diking of the tanks has been provided where necessary. Flood level alarms give the alert, followed by cleanup. Rupture of any piping will not produce whip into any safety class equipment or piping. All essential portions of the system are located away from any high energy lines. Two level instruments, one for the process control and indication and other for the indication and alarm, are provided on all the essential equipment of the process. Moreover, the I&C are provided outside the concentrated boron areas to have no radiation exposure to operating personnel.

TABLE 9.3-10 EQUIPMENT VENT SYSTEM COMPONENT DESIGN DATA

Safety Valve Surge Tank

Quantity	1
Material	SA-240, TP-304
Design Temperature (°F)	250
Design Pressure (psig)	15
Design Code	ASME Section VIII
Safety Class	NNS
Design Volume (ft^3)	257

Reactor Coolant Evacuation Pump

Quantity	1
Material	SA-403, WP-316
Design Flow Rate (scfm)	20
Design Temperature (°F)	160
Design Pressure (psig)	150
Design Code	MFR's STD
Safety Class	NNS

Separator/Silencer

Quantity	1
Material	SA-240, TP-316
Design Temperature (°F)	160
Design Pressure (psig)	150
Design Code	ASME Section VIII
Safety Class	NNS

TABLE 9.3-11 EQUIPMENT AND FLOOR DRAINAGE SYSTEM COMPONENT DATA SUMMARY

Reactor Coolant Drain Tank Heat Exchanger	
Number	1
Heat Transfer Rate at Design Conditions (Btu/hr)	2.43×10^6
<u>Shell Side</u>	
Design Pressure (psig)	150
Design Temperature (°F)	250
Fluid	Component Cooling Water
Material	Carbon Steel
Flow (lb./hr)	150,000
Tube Side	
Design Pressure (psig)	150
Design Temperature (°F)	250
Fluid	Borated Reactor Coolant
Material	Austenitic Stainless Steel
Flow (lb./hr)	48578
<u>Reactor Coolant Drain Tank</u>	
Number	1
Design Capacity (gal)	350
Design Pressure (psig)	100
Design Temperature (°F)	250
Material	Austenitic Stainless Steel

Sump Pumps

Materials

Casing/Impeller	Alloy 20
Pump Drive Shaft	Type 316 Stainless Steel
Case Design Pressure	100 PSIG
Case Design Temperature	150°F

Pump Operating Parameters

Building	***Sump***	***Design Flow, GPM***	Design TDH (Ft H_20)
Containment	A	25	100
Containment	B	25	115
PAB	A	25	95
RHR/CBS Vault	A	25	115
RHR/CBS Vault	B	25	115
FSB	A	25	90
FSB	B	25	90
WPB	A	50	50
WPB	B	25	48
Admin.	(NA)	35	65
RCA Walk	A	30	55
RCA Walk	B	30	60
RCA Walk	C	30	20

TABLE 9.4-1 CODES AND STANDARDS FOR HVAC SYSTEM COMPONENTS

	Design	Fabrication
Fans	AMCA	AMCA
	MFG	MFG
Fan Motors		SSPC
	NEMA	NEMA
	ANSI	ANSI
Filters	ASHRAE	MFG
Filter Motors	NEMA	NEMA
	ANSI	ANSI
Heating Coils	ARI	None
Cooling Coils	ARI	ASME
	ASME Section III	Section III
Pumps	HI	MFG
	ANSI	
	AFBMA	
Heat Exchangers	ASME	ASME
Unit Heaters	AMCA	MFG
Controls	IEEE (Safety System only)	None
Liquid Chillers	ASME	ASME
	NEMA	NEMA
	ASHRAE	ASHRAE
	ARI	ARI
	MFG	MFG
Backdraft Dampers	MFG	MFG

The acronyms listed in this table are identified below:

ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
AFBMA	Anti-Friction Bearing Manufacturers Association
AMCA	Air Moving and Conditioning Association
SSPC	Steel Structures Painting Council
NEMA	National Electrical Manufacturers Association
ANSI	American National Standards Institute
IEEE	Institute of Electrical and Electronic Engineers
ARI	Air Conditioning and Refrigeration Institute
AISI	American Iron and Steel Institute
ASME	American Society of Mechanical Engineers
MFG	Manufacturer's Standards
HI	Hydraulic Institute

TABLE 9.4-1A GUIDELINES, CODES AND STANDARDS FOR HVAC DIGITAL CONTROL UPGRADE

1. Regulatory Guide 1.152, "Criteria for Programmable Digital Computer System Software in Safety-Related Systems of Nuclear Power Plants"
2. Regulatory Guide 1.153, "Criteria for Power, Instrumentation and Control Portions of Safety Systems"
3. Generic Letter 91-05, "Licensee Commercial Grade Procurement and Dedication"
4. Generic Letter 95-02, "Use of NUMARC/EPRI Report TR-102348, 'Guidelines on Licensing Digital Upgrades,' in Determining the Acceptability of Performing Analog to Digital Replacements Under 10 CFR 50.59"
5. IEEE 7-4.3.2-1993, "IEEE Standard Criteria for Digital Computers in Safety Systems of Nuclear Power Generating Stations"
6. IEEE 1012-1986, "IEEE Standard for Software Verification and Validation Plans"
7. IEEE 1028-1988, "IEEE Standard for Software Review and Audits"
8. IEEE 730-1989, "Software Quality Assurance Plans"
9. IEEE 603-1991, "IEEE Standard Criteria for Safety Systems for Nuclear Power Generating Stations"
10. IEEE 323-1974, "Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations"
11. IEEE 344-1975, "Guide for Seismic Qualification of Class 1E Electric Equipment for Nuclear Power Generating Stations"
12. IEC QP-055010-2, "Software and Computers in the Safety Systems of Nuclear Power Stations"
13. EPRI TR-102348, "Guidelines for Licensing of Digital Upgrades"
14. EPRI TR-102323, "Guideline for Electromagnetic Interference Testing in Power Plants"
15. EPRI TR-106439, "Guideline on Evaluation and Acceptance of Commercial Grade Digital Equipment for Nuclear Safety Applications"
16. EPRI NP-5652, "Guideline for the Utilization of Commercial Grade Items in Nuclear Safety Related Applications"
17. ASME NQA-1A-1995, Appendix 7A-2, "Non-mandatory Guideline for Commercial Grade Items"
18. ASME NQA-2A-1990 Addenda, Part 2.7 - "Quality Assurance Requirements of Computer Software for Nuclear Facility Applications"

TABLE 9.4-2 PRIMARY AUXILIARY BUILDING HVAC COMPONENT SYSTEM PERFORMANCE INFORMATION

Equipment	Supply System	Exhaust System (Non-Filtered)	PCCW & Boron Injection Pump Area	Filter Room	Boric Acid Tank Area
Fans					
Type	Centrifugal	Centrifugal	Vane Axial	Power Roof Ventilator	
Seismic Category I	No	No	Yes	No	
Safety Class	None	None	3	None	
Number	3 (2 operating, 1 standby)	3 (2 operating, 1 standby)	2	2	
Air Quantity/Fan (cfm)	55,590	21,670	10,000	4,000	
Drive	"V" Belt	"V" Belt	Direct	Direct	
Class 1E	No	No	Yes	No	

Equipment	Supply System	Exhaust System (Non-Filtered)	PCCW & Boron Injection Pump Area	Filter Room	Boric Acid Tank Area
Isolation Dampers					
Type	Parallel Blade	Parallel Blade			
Number	2 (in series)	2 (in series)			
Seismic Category I	Yes	Yes			
Safety Class	3	3			
Air Quantity (cfm)	23,400	23,400			
Operation	Automatic	Automatic			
Actuator	Pneumatic	Pneumatic			
Cooling/Heating Coils (Nonsafety-related)					
Type	Tube & Fin, Hot Water				
Number	2 Banks, 5 Coils Each				
Cooling Capacity	216,100				
Heating Capacity (Btu/hr/coil)	1,263,600				

Equipment	Supply System	Exhaust System (Non-Filtered)	PCCW & Boron Injection Pump Area	Filter Room	Boric Acid Tank Area
Pumps, Heating System (Nonsafety-related)					
Type	Centrifugal			Centrifugal	
Number	3 (2 operating, 1 standby)			1	
Motor Horsepower, (each)	20			5	
Design Capacity, gpm (each)	370			10	
Unit Heaters (Nonsafety-related)					
Type				Propeller Fan, Hot Water	Electric Propeller Fan
Number				4	2
Heating Capacity					
(Btu/hr./Unit)				34,250	--
(KW/Unit)				---	20
Motor Horsepower (each)				1/15	

Equipment	Supply System	Exhaust System (Non-Filtered)	PCCW & Boron Injection Pump Area	Filter Room	Boric Acid Tank Area
Steam/Hot Water Converter (nonsafety-related)					
Type	"U" Tube, Water in Tube, Steam in Shell				
Number	2				
Pumps-Cooling System (Nonsafety-related)					
Type	Centrifugal				
Number	2 (1 operating; 1 standby)				
Motor Horsepower (each)	40				
Design Capacity, gpm	500				

Equipment	Supply System	Exhaust System (Non-Filtered)	PCCW & Boron Injection Pump Area	Filter Room	Boric Acid Tank Area
Liquid Chillers(Nonsafety-related)					
Type	Centrifugal Air Cooled				
Number	2 (1 operating; (1 standby)				
Design Capacity (each) tons	201				

TABLE 9.4-3 PRIMARY AUXILIARY BUILDING NORMAL FILTERED EXHAUST SYSTEM PERFORMANCE INFORMATION

Component	Material	Description or Specification
Prefilter		
Roll Type	Fibrous Glass 2½" thick	Automatic advance, 1/16 horsepower motor UL
Class II		
Frame	Galvanized steel	
Efficiency		60% based on ASHRAE standard 52-68 Dust Spot Test - 75% at design air flow
Medium Efficiency Filters		
Type	Fibrous Glass	UL Listed, Class I, per UL-900
Frame	Galvanized steel	
Efficiency		80-85% based on ASHRAE 52-68 Dust Sport Test. 95% with 0.3 micron nondispersed DOP smoke per Mil Std. 282.
HEPA Filters		
Type	Molded glass without separators	MIL-F-51079A UL used to standard UL-586.
Casing	Chromized steel	14-gauge
Frame	Stainless steel	
Efficiency		99.97% at 0.3 microns at rated flow, 20% and 120% rated flow. Tested in accordance with DOP, Q107.
Qualification		Meet requirements of NRC Reg. Guide 1.140, qualified tested to MIL-F-51068.

Component	Material	Description or Specification
Filter media	Impregnated activated coconut shell carbon	NRC Reg. Guide 1.140
Attenuation factor for elemental iodine per 2"bed depth at 70% RH.		99%
Attenuation factor for methyl iodide per 2"bed depth at 70% RH.		99%
Impregnating Material	KI_3	
Ignition Temperature, °C		340
Bulk Density, lbs./cu. ft		32
Hardness, percent		95 minimum
Mesh Size (Tyler)		8x16
Weight of carbon, lbs.		14,028
Carbon Bed Envelope	Stainless steel, type 304	
Housing	Carbon steel, epoxy coated	
Fan		
Type		Centrifugal
Quantity		2 - 100% redundant fans
Air Flow, cfm		38255-43200
Drive		Direct
Housing	Steel	¼", epoxy coated
Fan wheel	Steel	Air foil section

TABLE 9.4-4 WASTE PROCESSING BUILDING NORMAL DESIGN CONDITIONS

Systems	Temperature (°F) (Dry Bulb)			Humidity		
	Summer		Winter	***Summer***		Winter
Boron Waste Storage Tank Area	10	-	0	95	-	10
Carbon Delay Bed Areas	70	-	50	50	-	10
Polymer Storage Tank Area	88	-	60	50	-	10
Recovery & Waste Evaporator Areas	120	-	50	95	-	10
Refueling Water Storage Tank	104	-	0	95	-	10
Reactor Makeup Water Storage Tank	104	-	50	95	-	10
Hydrogen Surge Tank Area	104	-	50	95	-	10
All Other Areas	104	-	50	95	-	10

TABLE 9.4-5 WASTE PROCESSING BUILDING HVAC SYSTEM PERFORMANCE DATA

Equipment	Supply System	Exhaust System	Decontamination Area	Ambient Carbon Delay Bed Areas	Waste Solidification Ventilation System
Fans				N/A	
Type	Centrifugal	Vane Axial Centrifugal	Vane Axial		Centrifugal
Quantity	2	3 (Vane Axial Boosters) 2 (Centrifugal)	1		2
Air Flow Rate/Fan (cfm)	61,940	75,810 (Centrifugal) 34,760 (Vane Axial) 13,910 (Vane Axial) 62,750 (Vane Axial)	3,900		30,000
Drive	"V" Belt	"V" Belt (Centrifugal) Direct (Vane Axials)	Direct		"V" Belt
Heating Coils		N/A		N/A	
Type	Tube & Fin, water/glycol				Tube & Fin water/glycol
Quantity	2 Banks, 4 Coils each				1 Bank, 2 Coils
Capacity (Btu/hr/bank)	4,661,000				2,350,000

Equipment	Supply System	Exhaust System	Decontamination Area	Ambient Carbon Delay Bed Areas	Waste Solidification Ventilation System
Pumps, Heating System		N/A		N/A	
Type	Centrifugal				Centrifugal
Quantity	3 (2 operating, 1 standby)				2 (1 operating, 1 standby)
Motor Horsepower (ea.)	15				3
Heat Exchanger, Steam to Hot Water		N/A		N/A	
Type	"U" Tube, Water in tube, steam in shell				"U" Tube, Water in tube, steam in shell
Quantity	1				1
Capacity (Btu/hr.)	9,322,000				2,650,000

Equipment	Supply System	Exhaust System	Decontamination Area	Ambient Carbon Delay Bed Areas	Waste Solidification Ventilation System
Filters		N/A		N/A	
Type	Roll Filters		Moisture Separator		Roll Filter
Quantity	5 sections (10'-5" high x 6' wide/section)		1		2 sections (10'-0" wide x 8'-6" high/ section)
Efficiency	85% ASHRAE Arrestance				85% ASHRAE Arrestance
Media	Graduated Density Spun Glass				Graduated Density Spun Glass

Equipment	Supply System	Exhaust System	Decontamination Area	Ambient Carbon Delay Bed Areas	Waste Solidification Ventilation System
Air Cleaning Unit	N/A		N/A	N/A	N/A
Type		Package consisting of roll, medium efficiency and HEPA filters			
Quantity		1			
Efficiency		Roll - 85% NBS Dust Spot Medium - 80% NBS Dust Spot HEPA - 99.97% DOP Smoke Test, 0.3 Micron Particles			
Media		Roll - 2" Thick Graduated Density Spun Glass Medium - Viscous Impingement, Group III of - ARI 680 HEPA - Glass per MIL-F-51079 as called for in MIL-F-51068			

Equipment	Supply System	Exhaust System	Decontamination Area	Ambient Carbon Delay Bed Areas	Waste Solidification Ventilation System
Air Conditioning Units	N/A	N/A	N/A		
Type				Packaged Direct Expansion Unit	Split system condensing unit w/central station air unit
Quantity				2	1
Air Flow Rate (cfm, ea.)				(1) 2,025 (2) 1,800	3,940
Static Pressure (in. W.G.)				0.9	1.0
Fan Type				Centrifugal	Centrifugal
Drive				"V" Belt	"V" Belt
Cooling Capacity (Btu/hr., ea.)				40,646	86,208
Compressor				Hermetic	Hermetic
Filters				20% Fiberglass	20% Fiberglass

TABLE 9.4-6 WASTE PROCESS BUILDING AREA VENTILATION SYSTEM PERFORMANCE DATA

Equipment	Hydrogen Surge Tank Area	Boron Waste Tank Areas	Elevator Equip. Room	Refueling Water & Reactor Makeup Storage Tank Areas
Fans				
Type	Centrifugal	Power Roof Ventilators	Power Roof Ventilators	Power Roof Ventilators
Quantity	1	4	1	2
Air Flow Rate/Fan cfm	20,000	3,050	580	17,210
Drive	"V" Belt	"V" Belt	"V" Belt	"V" Belt

Equipment	Steam Gen. Blowdown. Recovery Building	Asphalt Storage Room	W. Mechanical Equipment Room
Fans			
Type	Power Roof Ventilator	Air Handling Unit (supply)	Power Roof Ventilator
Quantity	1	1	1
Air Flow Rate/Fan cfm	4,000	6,150	4,000
Drive	"V" Belt	"V" Belt	"V" Belt

TABLE 9.4-7 CONTAINMENT STRUCTURE HEATING AND COOLING SYSTEMS OPERATIONS VS. OPERATIONAL CONDITIONS

	Operating Systems	Operational Conditions
		Normal Conditions
1.	All Heating and Cooling Systems	Refer to Figure 3.11-1for containment structure environmental conditions.
		Accident (DBA)
2.	Containment recirculating fans and associated dampers. All Other systems are isolated from Containment, or are not required to operate during an accident	Refer to Figure 3.11-1 for containment structure environmental conditions.
		MSLB
		For short-term conditions, refer to Figure 1 and Figure 2 of Updated FSAR Fig.3.11-1. For long-term conditions, use "LOCA" profile from above figures.
		Post-Accident
3.	(Same as (2) above)	Refer to Figure 3.11-1 for containment structure environmental conditions.
		Minor Accident (Non-DBA)
4.	Containment recirculating fans and dampers may operate, but are not required. All other equipment is not required to operate during this condition.	Refer to Figure 3.11-1 for containment structure environmental conditions.
		Test (Containment Structure)
5.	Three containment structure cooling units will operate at low speed. Containment recirculating fans are capable of being operated, if required. Pressure may be relieved through the Containment Online Purge System.	Refer to Figure 3.11-1 for containment structure environmental conditions.

TABLE 9.4-8 CONTAINMENT STRUCTURE HVAC SYSTEM DESIGN AND PERFORMANCE DATA

Equipment	Containment Air Purge Systems: Containment Pre-Entry Purge Subsystem	Containment Air Purge Systems: Containment Refueling Purge & Heating Subsystem	Containment Online Purge System	Containment Structure Cooling Units	Control Rod Drive Mechanism Cooling Subsystem	Containment Structure Recirculating Filter System
Fans						
Type	Centrifugal	Centrifugal	Centrifugal	Centrifugal	Vane Axial	Vane Axial
Quantity	2 (1 supply, 1 exhaust)	2 (1 supply, 1 exhaust)	1	6 (5 operating, 1 standby)	3 (2 operating, 1 standby)	2 (1 operating; 1 standby)
Design Air Flow Rate/Fan(cfm)	11,000 Supply [1]15,000 Exhaust	40,000	1,000	56,000	25,000	4,000
Drive	"V" Belt	"V" Belt	Direct	Direct	Direct	Direct

1 Includes 4000 cfm exhaust from RCA tunnel.

Equipment	Containment Air Purge Systems Containment Pre-Entry Purge Subsystem	Containment Refueling Purge & Heating Subsystem	Containment Online Purge System	Containment Structure Cooling Units	Control Rod Drive Mechanism Cooling Subsystem	Containment Structure Recirculating Filter System
Air Cleaning Unit		N/A	N/A	N/A	N/A	Packaged, consisting of prefilter, HEPA filter and carbon adsorber trays
Type	Packaged, consisting of prefilter, HEPA filter and carbon adsorber bed.	Packaged, consisting of prefilter, HEPA filter.	Note: Exhaust through PAB normal exhaust air cleaning unit.			
Quantity						
Prefilter	12-24x24x12	25-24x24x2				3-24x24x12
HEPA	12-24x24x12	25-24x24x12				3-24x24x12
Carbon Adsorber	6-4" deep carbon beds (2,500 cfm each)					12-2" deep carbon beds

Equipment	Containment Air Purge Systems Containment Pre-Entry Purge Subsystem	Containment Refueling Purge & Heating Subsystem	Containment Online Purge System	Containment Structure Cooling Units	Control Rod Drive Mechanism Cooling Subsystem	Containment Structure Recirculating Filter System
Efficiency						
Prefilter		60% (ASHRAE 52-58)				60% (ASHRAE 52-58)
HEPA		99.97% for elemental 3 micron particles				99.97% 3 micron particles
Carbon Adsorber	99.9% for elemental iodine 99.5% for methyl iodine					99.9% for elemental iodine 99.5% for methyl iodine
Media						
Prefilter		Fibrous glass, UL Class 1				Fibrous glass, UL Class 1

Equipment	Containment Air Purge Systems: Containment Pre-Entry Purge Subsystem	Containment Air Purge Systems: Containment Refueling Purge & Heating Subsystem	Containment Online Purge System	Containment Structure Cooling Units	Control Rod Drive Mechanism Cooling Subsystem	Containment Structure Recirculating Filter System
HEPA		Glass per MIL-F-51079 as called for in MIL-F-51068				Glass per MIL-F-51079 as called for in MIL-F-51068
Carbon Adsorber	4" deep beds of activated carbon					4" deep beds of activated carbon
Dampers						
Type	Automatic	Automatic	Backdraft	Backdraft	Backdraft	Automatic
Quantity	(1 supply, 1 exhaust)	(1 supply, 1 exhaust)	(1 supply only)	6 (1 each unit)	3 (1 each unit)	4 (2 each fan)
Operator	Pneumatic	Pneumatic	None	None	None	Pneumatic

TABLE 9.4-9 CONTAINMENT ENCLOSURE AREA COOLING AND VENTILATION SYSTEM PERFORMANCE PARAMETERS

A. Equipment: Containment Enclosure Area Normal/Accident

Cooling Units (2)

Fans

Type	Centrifugal
Seismic Category	I
Safety Class	3
Quantity	2
Air Quantity/Fan (cfm)	76,800 @ 92°F entering air
Fan Class	III
Drive	Direct
Class 1E	Yes

Dampers

Type	Backdraft
Quantity	2
Seismic Category	I
Safety Class	3
Operation	Automatic

Cooling Coils

Type	Copper Tube/Aluminum Fin
Safety Class	3
Seismic Category	I
Cooling Capacity (Btu/Hr.)	1,180,000/1,563,000

A. Equipment: Containment Enclosure Area Normal/Accident
Continued

Cooling Units (2) (Continued)

Entering Water Temp. (°F)	85/120
Leaving Water Temp. (°F)	91.3/129.6
Water Flow Rate (gal./min.)	325/325

Filters

Type	Fiberglass replaceable
Quantity-Size	(2) 36-20" x 25" x 2" thick (2) 24-20" x 20" x 2" thick
Efficiency	75% avg. resistance, ASHRAE 52-68

*Air Cleaning Units (2)

Fans

Type	Centrifugal
Quantity	2
Seismic Category	I
Safety Class	3
Air Quantity/Fan (cfm)	2025-2275

* See Table 6.5-4 for filter material information

B. Equipment: H2 Analyzer Room & Electrical Room

Fan

Quantity	2
Type	Vaneaxial
Air Flow (cfm)	2900
Drive	Direct
Class 1E	Yes
Seismic Category	I

Filter

Quantity	2
Type	Throw-away
Size	20"x24"x2"
Safety Class	None
Seismic Category	None

Unit Heater

Quantity	2 (one per room)
Type	Electric
Size, KW	1-7.5 KW (H_2 Analyze Room)
Safety Class	None
Seismic Category	I (supports only)

C. Equipment: RHR Vault Stairway Area

Cooling Units (2)	North	South
Fan		
Quantity	2	2
Type	Centrifugal	Centrifugal
Air Flow (cfm)	2180	2440
Drive	V-Belt	V-Belt
Class 1E	No	No
Seismic Category	None	None
Coil		
Type	Copper Tubes, Aluminum Fins	Copper Tubes, Aluminum Fins
Cooling Capacity (Btu/hr)	69,000	75,000
Emt. Water/Lvg. Water (°F)	48/59.4	48/58.7
Water Flow (gpm)	14	16
Safety Class	None	None
Seismic Category	None	None
Filter		
Quantity	4	4
Type	Throw-away	Throw-away
Size	20"x25"	20"x25"
Safety Class	None	None
Seismic Category	None	None

Chiller and Pump (See E.)

D. Equipment: Electrical Tunnel Personnel Walkway — Normal/Accident

Cooling Unit (2)

Fan

Quantity	2
Type	Centrifugal
Air Flow (cfm)	2040
Drive	V-Belt
Class 1E	No
Seismic Category	None

Coil

Type	Copper Tube, Aluminum Fins
Cooling Capacity (Btu/hr)	66,000
Emt. Water/Lvg. Water (°F)	48/59.7
Water Flow (gpm)	13
Safety Class	None
Seismic Category	None

Filter

Quantity	4
Type	Throw-away
Size	20"x25"
Safety Class	None
Seismic Category	None

Chiller and Pump
(See E.)

E. Equipment: Common to Areas B, C and D

Chiller

Quantity	2 (1-standby)
Type	Air cooled
Compressor	Semi-hermatic (one)
Capacity	18.6 ton
Refrigerant	R-22
Fluid	40% Glycol Solution
Flow	43 gpm
Class 1E	No
Seismic Category	None

F. Equipment: *Common to Areas B, C and D* Normal/Accident

Chiller Pump

Quality	2 (1-standby)
Type	Centrifugal
Capacity	43 gpm @ 50 ft head
Fluid	40% Glycol Solution
Horsepower	1.5
Class 1E	No
Seismic Category	None

TABLE 9.4-10 ELECTRICAL PENETRATION AREAS AIR CONDITIONING SYSTEM PERFORMANCE INFORMATION

Equipment	Train A	Train B
Compressor/Condenser		
Type	Draw-thru, compressor with coil	Draw-thru, compressor with coil
Quantity	2 (one standby)	2 (one standby)
Compressor		
Type	Hermetic	Hermetic
Quantity	1	1
Condenser Fans		
Type	Propeller	Propeller
Quantity	2	2
Condenser Coil		
Type	2-row aluminum fin, copper tube.	2-row aluminum fin, copper tube.
Accessories	Compressor crankcase heaters, low ambient motor speed controller to -20°F.	Compressor crankcase heaters, low ambient motor speed controller to -20°F.
Fan Coil Unit		
Type	Vertical, draw-thru	Vertical, draw-thru
Quantity	2 (one standby)	2 (one standby)
Air Flow Rate (cfm)	2,500	5,000
Static Pressure (in W.G)	0.8	1.0
Fan Type	Centrifugal	Centrifugal
Quantity	1	2
Drive	"V" Belt	"V" Belt
Motor Horsepower	1	3 (one motor with double drive shaft)
Cooling Capacity		
Total (Btu/hr.)	45,000	104,500
Sensible (Btu/hr.)	45,000	104,500
Coil Type	Direct expansion, aluminum fin, copper tube.	Direct expansion, aluminum fin, copper tube.
Filter Type	Clearable (permanent)	Clearable(permanent)
Efficiency	10% ASHRAE average atmospheric dust	10% ASHRAE average atmospheric dust

TABLE 9.4-11 DIESEL GENERATOR BUILDING HEATING AND VENTILATION SYSTEM PERFORMANCE INFORMATION

Components	***Train A***	***Train B***
Supply Air Fans		
Type	Centrifugal	Centrifugal
Quantity	1	1
Air Flow Rate		
Air Flow Rate (cfm)	65,639	65,639
Drive	Direct	Direct
Exhaust Air Fans		
Type	Vaneaxial	Vaneaxial
Quantity	1	1
Air Flow Rate (cfm)	65,639	65,639
Drive	Direct	Direct
Unit Heaters		
Type	Hot water, fin/tube	Hot water, fin/tube
Quantity	4	4
Heating Capacity (Btu/hr)	56,000 (ea.)	56,000 (ea.)
Drive	Direct	Direct
Dampers		
Supply		
Type	Backdraft	Backdraft
Number	1	1
Size	68"x52"	68"x52"
Exhaust		
Type	Parallel Multi-blade	Parallel Multi-blade
Number	1	1
Actuator	Pneumatic, 2-position	Pneumatic, 2-position
Size	62"x62"	62"x62"
Fail Position	Fail Open	Fail Open
Filters		
Type	Roll	Roll
Quantity	1 bank	1 bank
Size (length x height)	25'x14'-2"	25'x14'-2"
Safety Class	None	None
Seismic Category	None	None

TABLE 9.4-12 4-KV SWITCHGEAR AREA, BATTERY ROOMS AND ELECTRICAL TUNNELS HEATING AND VENTILATION SYSTEMS PERFORMANCE INFORMATION

4-kV Switchgear Area and Battery Room Supply Fans (FN-19 and FN-32)

	FN-19	FN-32
Type	centrifugal	centrifugal
Air quantity/fan, scfm	38,400	29,800
Fan drive	V-belt	V-belt
Electrical characteristics	460V, 3φ, 60 Hz	460V, 3φ, 60 Hz

Battery Room Area Backdraft Dampers (DP-59A and 59B)

	DP-59A	DP-59B
Damper size, ft^2	1.69	1.69
Air quantity, scfm	2,600	2,600
Operator type	None	None

4-kV Switchgear Train A and Train B Areas Return Fan (FN20)

Quantity	1
Type	centrifugal
Air quantity, cfm	33,500
Fan drive	V-belt
Electrical characteristics	460V, 3φ, 60 Hz

4-kV Switchgear Train B Area Return Fan (FN33)

Quantity	1
Type	centrifugal
Air quantity, cfm	19,200
Fan drive	V-belt
Electrical characteristics	460V, 3φ, 60 Hz

4-kV Switchgear Area Return Fan Discharge Backdraft Dampers (DP-56 and DP-58)

	DP-56	DP-58
Quantity	1	1
Damper size, ft^2	19.88	17.01
Air flow, cfm	33,500	19,200
Operator type	None	None

4-kV Switchgear Area Exhaust Dampers (DP-24C and DP-24D)

	DP-24C	DP-24D
Quantity	1	1
Damper size, ft^2-fail open	17.19	14.54
Air flow, cfm	44,800	24,700
Operator type	pneumatic	pneumatic

4-kV Switchgear Area Recirculation Dampers (DP-24B and DP-24E)

	DP-24B	DP-24E
Damper size, ft^2 (fails as-is)	28.59	28.59
Air flow, cfm	44,800	24,700
Operator type	pneumatic	pneumatic

4-kV Switchgear Train A Area Intake Damper (DP-24A)

Quantity	1
Damper size, ft^2, (fails as-is)	29.77
Air flow, cfm	49,700
Operator type	pneumatic

4-kV Switchgear Train B Area Intake Damper (DP-24F)

Quantity	1
Damper size, ft^2, (fails as-is)	29.77
Air flow, cfm	29,800
Operator type	pneumatic

Control Building Exhaust Louver (L-7)

Quantity	1
Louver size, ft^2	176
Max. air flow, cfm	83,200

Control Building Exhaust Louver (L-8)

Quantity	1
Louver size, ft^2	176
Max. air flow, cfm	58,900

Exhaust Fans (FN 21A and 21B)

Quantity	2
Type	centrifugal
Air quantity - scfm (each)	5,400
Fan drive	V-belt
Electrical characteristics	460V, 3φ, 60 Hz

Battery Room Exhaust Fan - Suction Dampers (DP-21A and DP-21B)

Quantity	2
Damper size, ft^2	5.63
Air flow per damper, scfm	5,400
Type operator	pneumatic

Battery Room Exhaust Fan - Discharge Backdraft Dampers (DP-57A and DP-57B)

Quantity	2
Damper size, ft^2	4.51
Air flow per damper, scfm	5,400
Type operator	None

Electrical Cable Tunnel Return Fan (FN-22)

Quantity	1
Type	centrifugal
Air quantity, scfm	5,500
Fan drive	V-belt
Electrical characteristics	460V, 3φ, 60 Hz

Electrical Cable Tunnel Return Fan Discharge Backdraft Damper (DP-761)

Quantity	1
Damper size, ft^2	2.2
Air flow, scfm	5,500
Type operator	None

TABLE 9.4-13 EMERGENCY FEEDWATER PUMPHOUSE HEATING AND VENTILATING EQUIPMENT PERFORMANCE INFORMATION

A. Pumphouse Ventilation System

Fans

Type	Vane Axial
Number	2
Air Quantity/Fan (cfm)	14,000
Drive	Direct
Motor Horsepower	5
Safety Class	3
Seismic Category	I
Motor Class	1E

Intake Dampers

Type	Parallel Multi-Blade Tornado
Number	2
Size	48"x48"
Operator	Pneumatic
Safety Class	3
Seismic Category	I
Damper Position (normal flow/no flow)	Open/Closed

A. Pumphouse Ventilation System (Cont'd)

Exhaust Dampers

Type	Parallel Multi-Blade Tornado
Number	2
Size	84"x48"
Operator	Pneumatic
Safety Class	3
Seismic Category	I
Damper Position (normal flow/no flow)	Open/Closed
Damper Position (compressed air or electric failure)	Open

B. Pumphouse Heating System

Unit Heaters

Type	Hot Water/Glycol
Number	2
Capacity, each (Btu/hr)	98,000

Pumps

Type	Centrifugal
Number	2
Disch. Head (ft)	18
Flow rate (gpm)	20

Converter

Type	"U" tube, 2 pass, water in tube, steam in shell
Number	1
Rating (Btu/hr)	230,000

TABLE 9.4-14 SERVICE WATER PUMPHOUSE HEATING AND VENTILATING EQUIPMENT PERFORMANCE INFORMATION

Equipment	Pump Room	Switchgear Rooms
Fans		
Type	Vane Axial	Vane Axial
Number	2	2
Air Quantity/Fan (cfm)	22,000	3,400[(1)]
Drive	Direct	Direct
Safety Class	3	3
Seismic Category	I	I
Unit Heaters		
Type	Hot Water	Electric
Number	5	4
Size, each (kw)	--- ---	(2) 7.5 (Train A Switchgear Area) (2) 5.0 (Train B Switchgear Area)
Size, each (Btu/hr)	72,000	---
Safety Class	None	None
Seismic Category	None	None
Equipment Filters	N/A	
Type		Roll
Number		2
Size		2'-2"x5'
Media		Fibrous Glass, 2½" thick
Safety Class		None

(1) One fan serves both Train A and Train B switchgear areas, with 2800 cfm of air directed to the Train A area, and 600 cfm to the Train B area.

Equipment	Pump Room	Switchgear Rooms
Supply Dampers		
Type/actuator	Parallel Multi-Blade/Pneumatic	Backdraft/gravity
Number	2	2
Size	96"x66"	24"x24"
Safety Class	3	3
Seismic Category	I	I
Exhaust Dampers		
Type/actuator	Backdraft/gravity	Backdraft/gravity
Number	2	2
Size	48"x36"	30"x30" (Train A Switchgear Area) 12"x12" (Train B Switchgear Area)
Safety Class	3	3
Seismic Category	I	I
Tornado Dampers	N/A	
Number		3
Size		30"x36" (Intake) 30"x30" (Train A Switchgear Area) 12"x12" (Train B Switchgear Area)
Safety Class		3
Seismic Category		I

TABLE 9.4-15 SERVICE WATER COOLING TOWER HEATING AND VENTILATING EQUIPMENT PERFORMANCE INFORMATION

Equipment	Switchgear Vent. Supply System	Pump Room Exhaust System
Fans		
Type	Centrifugal	Centrifugal
Number	One per room	2
Air Quantity/Fan (cfm)	4,300	10,500
Drive	"V" Belt	Direct
Safety Class	3	3
Seismic Category	I	I
Unit Heaters		
Type	Electric	
Number	Two per room	
Size, KW, each	7.5	
Safety Class	None	
Seismic Category	None	
Filters		
Type	Flat Roughing Filter	
Number	1	
Size	10'x10'	
Safety Class	None	
Seismic Category	None	

Equipment	Switchgear Vent. Supply System	Pump Room Exhaust System
Louvers		
Type	Fixed (Exhaust)	Fixed (Intake, Common to both systems)
Number	One per Switchgear Train	One per equip. room
Size	8'-4½"x2'-6"	9'x10'
Safety Class	None	None
Seismic Category	None	None

Dampers

Type	Relief	Automatic	Fire	Backdraft
Number	1 per Switchgear Train	1 per Switchgear Train	1 per Switchgear Train	2
Size	8'-4½" W 2'-6" H	20"x28"	20"x28"	28"x28"
Safety Class	3	3	3	3
Seismic Category	I	I	I	I

TABLE 9.4-16 FUEL STORAGE BUILDING HEATING AND VENTILATION SYSTEM PERFORMANCE PARAMETERS

Equipment

Supply Dampers

Type	Balancing Blade Opposed Blade
Quantity	7
Seismic Category	1(Supports Only)
Safety Class	Nonsafety-related
Operation	Manual
Type	Tornado
Quantity	1
Seismic Category	I(Supports Only)
Safety Class	3
Operation	Pneumatic
Type	Fire
Quantity	1
Seismic Category	1
Safety Class	2
Operation	Self Closing
Type	Isolation Opposed Blades
Quantity	2
Seismic Category	I
Safety Class	2
Operation	Automatic Modulating

Exhaust Dampers

Type	Backdraft Parallel Blades
Quantity	2
Seismic Category	I(Support Only)
Safety Class	3
Operation	Self-closing
Type	Isolation Parallel Blades
Quantity	2
Seismic Category	I
Safety Class	3
Operation	Pneumatic
Type	Balancing Opposed Blade
Quantity	2
Seismic Category	I(Support Only)
Safety Class	Nonsafety-related
Operation	Manual
Type	Tornado
Quantity	1
Seismic Category	I(Support Only)
Safety Class	3
Operation	Self Closing
Type	Tornado
Quantity	1
Seismic Category	I(Supports Only)
Safety Class	3
Operation	Pneumatic

Exhaust Fan

Type	Vaneaxial
Quantity	1
Seismic Category	I
Safety Class	NSS
Air Quantity/Fan (cfm)	34,000

*Air Cleaning Units (2)

Fans

Type	Centrifugal
Quantity	2
Seismic Category	I
Safety Class	3
Air Quantity/Fan (cfm)	15,200-17,700

Dampers

Type	Parallel Blade
Quantity	2
Air Flow (cfm)	15,200-17,000

Pump, Heating System
(Nonsafety-related - Located in PAB)

Type	Centrifugal
Number	1
Motor Horsepower	10
Design Capacity, gpm	50

* See Table 6.5-5 for filter material information.

Unit Heaters
(Nonsafety-related)

Type	Propeller Fan Hot Water
Number	9
Heating Capacity (Btu/hr/unit)	77,080
Motor Horsepower (each)	1/6

TABLE 9.4-17 CONTROL ROOM COMPLEX AIR CONDITIONING SYSTEM PERFORMANCE INFORMATION

Equipment	Trains A & B
Control Room Air Conditioning Unit	
Type	Horizontal, draw-thru consisting of a fan section, cooling coil section and filter section
Quantity	2
Seismic Category	I - all components
Safety Class	3 - all components except filter
Fans	Centrifugal, nonoverloading with backward curved blades
Quantity	1 (per AC unit)
Air Flow Rate (cfm)	25,700
Drive	"V" Belt
Class 1E	Yes
Filter	
Type	Disposable, flat filter with micro glass media
Size	Nominal 20" x 25" x 2" thick
Quantity	15 (per AC unit)
Efficiency	>75% dust arrestance per ASHRAE 52.1-1992

Chillers

Type	Air cooled, scroll
Safety Class	3
Seismic Category	I
Quantity	1 (per Train)
Cooling Capacity, tons	62.2
Cooling Medium	Ethylene glycol/water(35-40% by volume)
Refrigerant	R22

Cooling Coils

Type	Chilled water, aluminum fins, copper tubes
Safety Class	3
Seismic Category	I
Quantity	1 (per Train)
Cooling Medium	Ethylene glycol/water(35-40% by volume)
Cooling Capacity, btu/hr	704,300

Pumps

Type	Centrifugal
Safety Class	3
Seismic Category	I
Quantity	2 (per Train)
Water Flow Rate, gpm	170
Total Developed Head (Ft. of water)	150
Pump RPM	3500
Motor HP	15
Motor RPM	3600

Expansion Tank

Type	Horizontal, steel, ASME Section VIII
Safety Class	3
Seismic Category	I
Quantity	1 (per Train)
Volume, gal	60

Temperature Control Valve

Type	3-way, diverting (bypass)
Safety Class	3
Seismic Category	I
Quantity	1 (per Train)
Actuator	Electric, 120 VAC
Controller	2-12 vdc

Chiller Condenser Exhaust Fans

Type	Vaneaxial
Safety Class	3
Seismic Category	I
Quantity	1 (per Train)
Air Flow Rate, cfm	40,700
Pressure Drop (Inches water gauge)	2.97
Fan Brake horsepower BHP	31
Motor HP	40
Motor RPM	1750

Computer Room Air Conditioning Unit	
Type	Vertical, floor mounted, consisting of a fan section, cooling coil section and filter section
Quantity	1
Seismic Category	None
Safety Class	None
Fans	Centrifugal, nonoverloading with backward curved blades
Quantity	1 (per AC unit)
Air Flow Rate (cfm)	10,400
Drive	"V" Belt
Class 1E	No
Coil	
Type	Direct expansion, aluminum fin, copper tube
Quantity	1 (per AC unit)
Cooling Capacity (Btu/hr)	130,193
Filter	
Type	Disposable, high velocity
Quantity	6
Size	16"x25"x2" thick
Efficiency	30-35% per ASHRAE std. 52-68

Computer Room
Condensing Unit

Type	Vertical, draw-thru
Quantity	2
Safety Class	None
Seismic Category	None

Fans

Type	Four bladed aluminum propeller
Quantity	2 (per condensing unit)
Air Flow Rate (cfm)	4,000 (per fan)
Drive	Direct
Class 1E	No

Coil

Type	Direct expansion, aluminum fin, copper tube
Quantity	1 (per condensing unit)
Capacity (Btu/hr)	130,193

Compressor

Type	Semi-hermetic
Quantity	1 (per condensing unit)
Refrigeration Effect (Btu/hr)	130,193
Class 1E Motor	No
Accessories	Crankcase heater

Unit Heaters

Type	Electric, propeller fan
Quantity	6
Heating Capacity (KW/unit)	23
Safety Class	No

TABLE 9.4-17a CONTROL ROOM COMPLEX AIR CONDITIONING DESIGN AND PERFORMANCE INFORMATION - NON-SAFETY RELATED SYSTEM

Chillers	
Type	Air cooled, reciprocating
Quantity	2
Cooling Capacity, tons	38
Cooling Medium	Ethylene glycol/water
Refrigerant	R22
Cooling Coils	
Type	Chilled water, aluminum fins, copper tubes
Quantity	1 (per AC unit)
Cooling Medium	Ethylene glycol/water
Cooling Capacity, Btu/hr	704,000
Seismic Category	1
Safety Class	3
Pumps	
Type	Centrifugal
Water Flow Rate, gpm	100
Pump RPM	1750
Motor HP	10
Motor RPM	1800
Expansion Tank	
Type	Vertical, carbon steel, ASME Section VIII
Quantity	1
Volume, gal	120
Diaphragm	Butyl, 12 psi precharge with air

Air Separator

Type	In-line, carbon steel, ASME Section VIII
Quantity	1
Size, in	4

Temperature Control Valve

Type	3 way, diverting
Quantity	1
Actuator	Electric, 120VAC
Control	4-20 madc

TABLE 9.4-18 CONTROL ROOM COMPLEX MAKEUP AIR AND CLEANUP FILTER SYSTEM PERFORMANCE INFORMATION

Component	Material	Description or Specification
Emergency Clean-up Filter Units (2)		
	(See Table 6.5-6 for Filter Material Information)	
Fans		
Type - Train A	Carbon steel housing, aluminum blades and hub	Van Axial
Type - Train B	Carbon steel	Centrifugal
Quantity		1 (per filter unit)
Safety Class		3
Seismic Category		I
Air Flow Rate (cfm)		990-1210 (per fan)
Drive - Train A		Direct
Drive - Train B		Belt
Dampers		
Type		Backdraft
Quantity		2 (on each fan)
Safety Class		3
Seismic Category		I
Housing	10 ga. steel ASTM A569	
Blades	3/16" steel ASTM A36	

Component	Material	Description or Specification
Normal Makeup Air Fans		
Type	Carbon steel housing, aluminum blades and hub	Vane Axial
Quantity		2
Safety Class		3
Seismic Category		I
Air Flow Rate (cfm)		1000
Drive		Direct
Makeup Air Dampers		
Type		Round, single black automatic
Quantity		2 (one per fan)
Safety Class		3
Seismic Category		I
Frame	Steel ASTM A181 & A36	
Blade	10 ga. - ASTM A36	

TABLE 9.4-19 TURBINE BUILDING HVAC DESIGN AND PERFORMANCE DATA

Equipment	Turbine Hall	Heater Bay	Battery Room	Relay Room		Turbine Erectors's Office Electronics Work Room, Startup Room, SAS Room and SAS UPS Room[1]		Elevator Machinery Room	Turbine Lube Oil Tank Room	Feed Pump & Turbine RMS (North and South)	Lube Oil Storage Building
				Relay Room	Battery Room		Toilet Room				
Fans											
Type	Power Roof Ventilator (exhaust)	Power Roof Ventilators (exhaust)	Centrifugal Fan		Centrifugal exhaust fans	Air Conditioning Multizone Unit	Centrifugal Exhaust fan	Power Fan (exhaust)	Propeller Fan (exhaust)	Centrifugal Fan (exhaust)	Propeller Fan (supply)
Quantity	10	10	1		2	1	1	1	1	1 (each room)	1
Air Flow/ forms(cu ft/ min.)	55,000 max.	45,000 max.	2,000		350 (each fan)		150	3,000	1,700	15,000 (each fan)	1,000
Drive	"V" belt	"V" Belt	"V" Belt		"V" Belt		Direct	"V" Belt	Direct	"V" Belt	Direct
	15	10	1.5		1/3		1/25		0.5	7.5	1/6
<u>Air Conditioning Equipment Compressor/ Condenser</u>											
Type				Draw-thru compressor with coil		Draw-thru compressor with coil					
Quantity				1		1					
Compressor											
Type				Semi-hermetic		Hermetic					
Quantity				1		1					
Condenser Fan											
Type				Propeller		Propeller					
Quantity				3		1					
Motor H.P.				¾		¾					

Equipment	Turbine Hall	Heater Bay	Battery Room	Relay Room		Turbine Erectors's Office Electronics Work Room, Startup Room, SAS Room and SAS UPS Room[1]		Elevator Machinery Room	Turbine Lube Oil Tank Room	Feed Pump & Turbine RMS (North and South)	Lube Oil Storage Building
				Relay Room	Battery Room		Toilet Room				
Condenser Coil											
Type				Aluminum fin, copper tube. Fin mechanically bonded to tube		Aluminum fin, copper tube. Fin mechanically bonded to tube					
Self Contained											
Type						Room					
Quantity						4					
Accessories				Compressor crankcase heater, anti- short cycle device, low ambient motor speed controller to 0°F		Compressor crankcase heater, anti- short cycle device, low ambient motor speed controller to 0°F					

Equipment	Turbine Hall	Heater Bay	Battery Room	Relay Room		Turbine Erectors's Office Electronics Work Room, Startup Room, SAS Room and SAS UPS Room[1]		Elevator Machinery Room	Turbine Lube Oil Tank Room	Feed Pump & Turbine RMS (North and South)	Lube Oil Storage Building
				Relay Room	Battery Room		Toilet Room				
Fan Coil Unit											
Type				Horizontal draw-thru		Horizontal, draw-thru multizone.					
Quantity				1							
Air Flow Rate (cfm)				9,200		5,150					
Fan Type				Centrifugal		Centrifugal					
Drive				"V" Belt		"V" Belt					
Cooling Capacity											
Total(Btu/Hr)				278,000		142,000					
Sensible (Btu/Hr.)				219,000		113,000					
Coil Type, Cooling				Direct expansion, aluminum fin, copper tube, Fin is mechanically bonded to tube.		Direct expansion, aluminum fin, copper tube, Fin is mechanically bonded to tube.					
Refrigerant Accessories				Solenoid valve sight glass and expansion valves		Solenoid valve sight glass and expansion valves					
Coil type, heating				Electric, open wire resistance coil		Electric, open wire resistance coil					
Heating Capacity (Btu/hr.)				2" fibrous glass		2" fibrous glass					
Filter Type Efficiency				10% ASHRAE average atmospheric		10% ASHRAE average atmospheric					

Equipment	Turbine Hall	Heater Bay	Battery Room	Relay Room		Turbine Erectors's Office Electronics Work Room, Startup Room, SAS Room and SAS UPS Room[1]		Elevator Machinery Room	Turbine Lube Oil Tank Room	Feed Pump & Turbine RMS (North and South)	Lube Oil Storage Building
				Relay Room	Battery Room		Toilet Room				
Zone Dampers											
Type						Proportioning					
No. of Zones						3					
Actuator						Pneumatic Modulating					
<u>Equipment Dampers</u>											
Type	Parallel multiblade exhaust	Parallel multiblade exhaust		Parallel multiblade		Parallel multiblade		Parallel multiblade exhaust	Parallel multiblade exhaust		3-hr vertical fire
Quantity	10	10		2		2		1	1		1
Actuator	Motor	Motor		Pneumatic modulating		Pneumatic modulating					
Size Outside & Return Air				19½x70"		19½x62"					
Exhaust Dampers											
Type			Parallel multiblade backdraft exhaust	Proportioning multiblade	Parallel multiblade backdraft		None			Parallel multiblade exhaust	3-hr vertical fire
Quantity			1	1	2					2	4

Equipment	Turbine Hall	Heater Bay	Battery Room	Relay Room		Turbine Erectors's Office Electronics Work Room, Startup Room, SAS Room and SAS UPS Room[1]		Elevator Machinery Room	Turbine Lube Oil Tank Room	Feed Pump & Turbine RMS (North and South)	Lube Oil Storage Building
				Relay Room	Battery Room		Toilet Room				
Louvers											
Type	Movable	Movable	Fixed								
Quantity	7	10	1								
Intake/ Exhaust Louvers											
Type	Movable										
Quantity	8										

[1] The SAS UPS room is also air-conditioned using a 3-ton split system ductless air conditioner.

TABLE 9.4-20 COMPLIANCE OF PRIMARY AUXILIARY BUILDING NORMAL EXHAUST FILTRATION SYSTEM TO REGULATORY GUIDE 1.140, REV. 1 - OCTOBER 1979

Regulatory Guide Section	Applicability To This System	Comment Index
C.1.a	Yes	----
C.1.b	Yes	Note 1
C.1.c	Yes	----
C.1.d	Yes	----
C.2.a	Yes	----
C.2.b	Yes	Note 2
C.2.c	Yes	Note 3
C.2.d	Yes	----
C.2.e	Yes	----
C.2.f	Yes	Note 4
C.3.a	Yes	Note 5
C.3.b	Yes	----
C.3.c	Yes	Note 7
C.3.d	Yes	Note 8
C.3.e	Yes	Note 9
C.3.f	Yes	Note 10
C.3.g	Yes	Note 11
C.3.h	Yes	----
C.3.i	Yes	Note 12
C.3.j	Yes	----
C.3.k	Yes	----
C.3.l	Yes	Note 13
C.3.m	Yes	----

Regulatory Guide Section	Applicability To This System	Comment Index
C.4.a	Yes	Note 14
C.4.b	Yes	Note 15
C.4.c	Yes	Note 16
C.4.d	Yes	----
C.5.a	Yes	Note 6
C.5.b	Yes	Note 6
C.5.c	Yes	Note 6 & 18
C.5.d	Yes	Note 6 & 18
C.6.a	Yes	Note 7
C.6.b	Yes	Note 7

COMMENT INDEX NOTES FOR TABLE 9.4-20

Note 1 The majority of components of the system are located in Service Environment Zone PB-1. In accordance with Service Environment Chart, Figure 3.11(B)-1, the radiation level during normal plant operation is 1.0×10^3 rads. Hence, no special shielding of the components or to personnel is necessary.

Note 2 The atmospheric unit has a design rated capacity range of 38,125 scfm dirty condition to 43,200 scfm clean condition. The required operational efficiencies of HEPA and charcoal adsorber have not been compromised as a result of increased flow rate. In-place testing reliability has also not been compromised.

Note 3 The pressure drop across each filter bank, i.e., roll filter, pre-filter, HEPA filter and carbon filter are monitored. High pressure drop across the entire unit is alarmed in plant computer. The condition of low flow is also alarmed in the plant computer. The high temperature downstream of the adsorber unit and high humidity condition upstream of the adsorber unit are also alarmed in the plant computer.

Note 4 The housing and ductwork, as defined in Subsection 5.10.8.1 of ANSI N-509-1980, are designed to exhibit a total leakage rate equal to or less than the criteria given in Section 4.12 of ANSI N-509-1980 when tested in accordance with the procedures outlined in ANSI N-510-1980.

Note 5 During normal plant operation, the overall relative humidity of entering air to the adsorber unit is not expected to be more than 70%. However, in the case of excess of 70% RH, a computer alarm is generated for manual corrective action. Hence, the electric heating coil or dehumidifying coil have not been utilized.

Note 6 All in-place testing/inspection for activated carbon and adsorber cell will be performed per ANSI N-510-1980 requirements.

Note 7 The filter and adsorber mounting frames were designed prior to issuance of Reg. Guide 1.140, Rev. 1. They are designed and constructed per Section 4.3 of ERDA 76.21 publication.

Note 8 The design air flow capacity range of the unit is from 38,125 scfm to 43,200 scfm, which resulted in the arrangement of pre-filters and HEPA filters in 6 wide x 5 high array with a permanent installed serviceable platform after the 3rd bank. Fourteen 4-inch deep beds with fourteen 2-inch guard beds for each carbon adsorber unit have been arranged to meet efficiency and residence time requirements.

Note 9 The filtration housings were designed prior to the issuance of Regulatory Guide 1.140, Rev. 1. However, they meet the intent of ANSI N-509-1976 and ERDA 76.21 requirements.

Note 10 The ductwork associated with the system has been designed and constructed to meet the intent of Section 5.10 of ANSI N-509-1976. It is field tested/inspected per procedures outlined in ANSI N-510-1980, with the acceptance criteria and other related requirements outlined in ANSI N-509-1980.

Note 11 The adsorbent used in the system is coconut shell base natural grain activated charcoal, qualified per ANSI N-509-1976 requirements.

Note 12 The system fan and motor, mounting and ductwork connections were procured prior to the issuance of Reg. Guide 1.140, Rev. 1. However, they are designed and constructed to meet the intent of Sections 5.7 and 5.8 of ANSI N-509-1976. They are field tested/inspected as applicable per Section 8 of ANSI N-510-1980.

Note 13 The system dampers were procured prior to the issuance of Reg. Guide 1.140, Rev. 1. However, they are designed, constructed and tested per the intent of Section 5.9 of ANSI 509-1976 and ANSI 510-1975. They are field tested/inspected as a part of ductwork per ANSI N-510-1980, with the acceptance criteria of ANSI N-509-1980.

Note 14 The procurement of components and design of the system layout was performed prior to the issuance of Reg. Guide 1.140, Rev. 1. However, they meet the requirements of Section 4.7 of ANSI N-509-1976 and the intent of Subsection 2.3.8 of ERDA 76.21.

Note 15 The filter unit was procured prior to the issuance of Reg. Guide 1.140, Rev. 1. Clear 3'-0" space has been provided between roll filter and pre-filter, pre-filter and HEPA filter, HEPA filter and carbon adsorbers, not including nominal component dimensions.

Note 16 In lieu of the testability criteria of Section 4.11 of ANSI N-509-1976, that of ANSI N-509-1980 are being complied with.

Note 17 Although the carbon has been qualified per ANSI N-509-1976 requirements, the in-place laboratory testing will be per ANSI N-510-1980 requirements.

Note 18 Painting is administratively controlled to protect the HEPA filters and the charcoal adsorbers from the adverse effects of the fumes.

TABLE 9.4-21 COMPLIANCE OF WASTE PROCESSING BUILDING FILTERED EXHAUST SYSTEM TO REGULATORY GUIDE 1.140, REV. 1 - OCTOBER 1979

Regulatory Guide Section	Applicability To This System	Comment Index
C.1.a	Yes	----
C.1.b	Yes	Note 1
C.1.c	Yes	----
C.1.d	Yes	----
C.2.a	Yes	Note 2
C.2.b	Yes	----
C.2.c	Yes	Note 3
C.2.d	Yes	----
C.2.e	Yes	----
C.2.f	Yes	Note 4
C.3.a	No	----
C.3.b	Yes	----
C.3.c	Yes	Note 6
C.3.d	Yes	----
C.3.e	Yes	Note 7
C.3.f	Yes	Note 8
C.3.g	No	----
C.3.h	No	----
C.3.i	Yes	Note 5
C.3.j	Yes	----
C.3.k	Yes	----
C.3.l	Yes	Note 9
C.3.m	Yes	----
C.4.a	Yes	Note 10

Regulatory Guide Section	Applicability To This System	Comment Index
C.4.b	Yes	----
C.4.c	Yes	Note 11
C.4.d	Yes	----
C.5.a	Yes	Note 12
C.5.b	Yes	Note 12
C.5.c	Yes	Note 12
C.5.d	No	----
C.6.a	No	----
C.6.b	No	----

COMMENT INDEX NOTES FOR TABLE 9.4-21

NOTE 1

The system components are located in a mild environment during normal plant operating conditions. Hence, no shielding for equipment or personnel protection has been provided.

NOTE 2

The atmosphere clean-up system is designed to remove only particulate matter and, hence, an iodine adsorption component has not been considered.

NOTE 3

The pressure drop across each filter bank is monitored locally. The atmosphere clean up unit high pressure drop across the entire unit has been alarmed in the plant computer. The entire system is located in a normally accessible area. In addition, a high temperature condition downstream of the HEPA filter is also alarmed in the plant computer.

NOTE 4

The housing and ductwork, as defined in Subsection 5.10.8.1 of ANSI N-509-1980, is designed to exhibit a total leakage rate equal to or less than the criteria given in Section 4.12 of ANSI N-509-1980 when tested in accordance with the procedure given in ANSI N-510-1980.

NOTE 5

The system fan and motor, mounting and ductwork connections were designed prior to issuance of Regulatory Guide 1.140, Rev. 1. However, they are designed and constructed to meet the intent of Section 5.7 and 5.8 of ANSI N-509-1976. They are field tested/ inspected per ANSI N-510-1980 requirements, with the acceptance criteria of ANSI N-509-1980.

NOTE 6

The filter unit frames were designed prior to issuance of Reg. Guide 1.140, Rev. 1. They are designed and constructed per Section 4.3 of ERDA 76.21 publication.

NOTE 7

The system filter housings, including floors, drains, conduits, interior piping, drains, etc., were designed prior to the issuance of Reg. Guide 1.140, Rev. 1. However, they do meet the intent of corresponding requirements of ANSI N-509-1976 and ERDA 76.21 publications.

NOTE 8

Ductwork associated with the atmospheric clean up unit is designed and constructed to meet the intent of Section 5.10 of ANSI N-509-1976 requirements. It is field tested/inspected per ANSI N-510-1980 requirements in conjunction with ANSI N-509-1980 requirements.

NOTE 9

The system dampers were procured prior to the issuance of Reg. Guide 1.140, Rev. 1. However, they are designed, constructed and shop-tested per the intent of Section 5.9 of ANSI N-509-1976. They are field-tested/inspected as a part of the ductwork system per ANSI N510-1980, with acceptance criteria of ANSI N-509-1980.

NOTE 10

The procurement of components and the system layout was performed prior to issuance of Reg. Guide 1.140, Rev. 1. They meet the requirements of Section 4.7 of ANSI N-509-1976 and the intent of Subsection 2.3.8 of ERDA 76.21.

NOTE 11

In lieu of testability criteria of Section 4.11 of ANSI N-509-1976, that of Section 4.11 of ANSI N-509-1980 are complied with.

NOTE 12

All field testing and inspection is performed per ANSI N-510-1980, with ANSI N-509-1980 acceptance criteria, as applicable.

TABLE 9.4-22 COMPLIANCE OF PRIMARY CONTAINMENT RECIRCULATING AIR-FILTRATION SYSTEM TO REGULATORY GUIDE 1.140, REV.1 - OCTOBER 1979

Regulatory Guide Section	Applicability To This System	Comment Index
C.1.a	Yes	----
C.1.b	Yes	----
C.1.c	Yes	----
C.1.d	No	Note 1
C.2.a	Yes	----
C.2.b	Yes	----
C.2.c	Yes	Note 2
C.2.d	Yes	----
C.2.e	No	Note 1
C.2.f	No	----
C.3.a	Yes	----
C.3.b	Yes	----
C.3.c	Yes	Note 4
C.3.d	Yes	----
C.3.e	Yes	Note 5
C.3.f	Yes	Note 6
C.3.g	Yes	Note 7
C.3.h	Yes	----
C.3.i	Yes	Note 8
C.3.j	Yes	----
C.3.k	Yes	----
C.3.l	Yes	Note 9

Regulatory Guide Section	Applicability To This System	Comment Index
C.3.m	Yes	----
C.4.a	Yes	Note 12
C.4.b	Yes	Note 3
C.4.c	Yes	Note 13
C.4.d	Yes	----
C.5.a	Yes	Note 10
C.5.b	Yes	Note 10
C.5.c	Yes	Note 10 & 14
C.5.d	Yes	Note 10 & 14
C.6.a	Yes	Note 11
C.6.b	Yes	Note 11

COMMENT INDEX NOTES FOR TABLE 9.4-22

GENERAL The system components downstream of the recirculating filter unit have dual functions:

1. Non-ESF function is to discharge the filtered air just below the 25'-0" floor elevation during normal reactor operation and,
2. ESF function is to isolate the recirculating filter unit and help in mixing potential hydrogen vapors from the dome area to the area just below the 25'-0" elevation.

Since Regulatory Guide 1.140, Rev. 1, applies only to non-ESF filter units, the compliance to the Reg. Guide is only discussed to relevant portions of the system.

NOTE 1

The entire air cleaning system is confined within the Containment Building.

NOTE 2

The pressure drops across individual filter banks, i.e., pre-filter, HEPA filter, and adsorber cells are monitored. High pressure drop across the entire unit is alarmed in the plant computer. High moisture level in upstream air and high temperature level in air downstream of the charcoal adsorber unit are also alarmed in the plant computer. The open/close positions of all control dampers are indicated on the main control board and logged into the plant computer.

NOTE 3

The filter unit was procured prior to the issuance of Reg. Guide 1.140, Rev. 1. A clear space of 3'-0" has been provided between pre-filter and HEPA, HEPA and carbon adsorber before allowing component dimension itself.

NOTE 4

The filter unit was designed prior to the issuance of Reg. Guide 1.140, Rev. 1. The filter and adsorber mounting frames are designed per Section 4.3 of ERDA 76.21 publication.

NOTE 5

The filtration unit components, including floor drains were designed prior to the issuance of Regulatory Guide 1.140, Rev. 1. They meet the intent of ANSI N-509-1976 and ERDA 76.21 publications.

NOTE 6

The associated ductwork was designed prior to issuance of Reg. Guide 1.140, Rev. 1. However, it is designed and constructed as safety-related ductwork, and meets the intent of Section 5.10 of ANSI N-509-1976. It is field-tested/inspected for air leakage performance in accordance with ANSI N-510-1980, with the acceptance criteria of ANSI N-509-1980.

NOTE 7

The adsorbent used is coconut shell base activated carbon, qualified per ANSI N-509-1976 requirements.

NOTE 8

The system fan and motor, mounting and ductwork were designed prior to issuance of Reg. Guide 1.140, Rev. 1. However, they are designed and constructed to meet the intent of Sections 5.7 and 5.8 of ANSI N-509-1976. They are field-tested/inspected per ANSI N-510-1980 requirements, with the acceptance criteria of ANSI N-509-1980.

NOTE 9

The system dampers were procured prior to issuance of the Reg. Guide. However, they are designed, constructed and shop-tested per the intent of ANSI N-509-1976 and ANSI N-510-1975. They are field-tested/inspected as a part of ductwork per ANSI N-510-1980 requirements, with the applicable acceptance criteria of ANSI N-509-1980.

NOTE 10

All field inspections and testing are done per ANSI N-510-1980 requirements, with the acceptance criteria of ANSI N-509-1980 as applicable.

NOTE 11

Although the carbon has been qualified per ANSI N-509-1976 requirements, the in-place laboratory testing will be per ANSI N-510-1980 requirements.

NOTE 12

The procurement of components and system layout was performed prior to issuance of Reg. Guide 1.140, Rev. 1. They meet the requirements of Section 4.7 of ANSI N-509-1976 and the intent of Section 2.3.8 of ERDA 76.21.

NOTE 13

In lieu of test ability criteria of Section 4.11 of ANSI N-509-76, that of Section 4.11 of ANSI N-509-1980 are complied with.

NOTE 14

Painting is administratively controlled to protect the HEPA filters and the charcoal absorbers from the adverse effects of the fumes.

TABLE 9.4-23 COMPLIANCE OF CONTAINMENT PRE-ENTRY AIR PURGE EXHAUST FILTER SYSTEM TO REGULATORY GUIDE 1.140, REV. 1 - OCTOBER 1979

Regulatory Guide Section	Applicability To This System	Comment Index
C.1.a	Yes	----
C.1.b	Yes	----
C.1.c	Yes	----
C.1.d	Yes	----
C.2.a	Yes	----
C.2.b	Yes	----
C.2.c	Yes	Note 1
C.2.d	Yes	----
C.2.e	Yes	----
C.2.f	Yes	Note 2
C.3.a	Yes	----
C.3.b	Yes	----
C.3.c	Yes	Note 4
C.3.d	Yes	----
C.3.e	Yes	Note 5
C.3.f	Yes	Note 6
C.3.g	Yes	Note 7
C.3.h	Yes	----
C.3.i	Yes	Note 8
C.3.j	Yes	----
C.3.k	Yes	----
C.3.l	Yes	Note 9
C.3.m	Yes	----
C.4.a	Yes	Note 3
C.4.b	Yes	----
C.4.c	Yes	Note 12
C.4.d	Yes	----
C.5.a	Yes	Note 10
C.5.b	Yes	Note 10
C.5.c	Yes	Note 10 & 13
C.5.d	Yes	Note 10 & 13
C.6.a	Yes	Note 11
C.6.b	Yes	Note 11

COMMENT INDEX NOTES FOR TABLE 9.4-23

GENERAL

Containment pre-entry air purge supply exhaust cap and refueling purge supply exhaust system utilize the common path to and from primary containment. To comply with the Regulatory Guide 1.140, Rev. 1, only pre-entry air purge supply exhaust systems have been evaluated.

NOTE 1

The pressure drops across individual filters, i.e., prefilter, HEPA filter and carbon adsorber, are locally monitored at the unit. The high pressure drop across the entire unit is alarmed in the computer. High moisture content entering the adsorber unit and high temperature downstream of the adsorber unit are alarmed in the plant computer. The position of system control/isolation dampers and isolation valves are indicated on the main control board. All control instruments, devices and test ports with the exception of inboard isolation valves are located in accessible area during normal reactor operation.

NOTE 2

Housing and ductwork, as defined in Subsection 5.10.8.1 of ANSI N-509-190, are designed to exhibit a total leakage rate equal to or less than the criteria given in Section 4.12 of ANSI N-509-1980 when tested in accordance with procedure outlined in ANSI N-510-1980.

NOTE 3

The procurement of components and system layout was performed prior to the issuance of Reg. Guide 1.140, Rev. 1. They meet the requirements of Section 4.7 of ANSI N-509-1976 and the intent of Subsection 2.3.8 of ERDA 76.21.

NOTE 4

The filter unit was designed and constructed prior to issuance of Regulatory Guide 1.140, Rev. 1. The filter and adsorber mounting frames were designed and constructed per Section 4.3 of ERDA 76.21 publication.

NOTE 5

The filtration unit components, including floor and drains, were designed prior to issuance of Reg. Guide 1.140, Rev. 1. However, they meet the intent of ANSI N-509-1976 and ERDA 76.21 requirements.

NOTE 6

The ductwork associated with the system is designed to meet the intent of Section 5.10 of ANSI N-509-1976. The exhaust ductwork penetrating the containment isolation boundary is designed, constructed and tested as safety-related Safety Class 2. The remaining ductwork is field-tested/inspected as required per ANSI N-510-1980, with the acceptance criteria of ANSI N-509-1980.

NOTE 7

The adsorbent used in the system is coconut shell base activated carbon, qualified per ANSI N-509-1976 requirements.

NOTE 8
The system fan and motor, mountings, and ductwork connections were designed and constructed prior to the issuance of Regulatory Guide 1.140, Rev. 1. However, they are designed and constructed to meet the intent of Sections 5.7 and 5.8 of ANSI N-509-1976. They are field-tested/inspected per ANSI N-510-1980.

NOTE 9
The system dampers were procured prior to the issuance of this Reg. Guide. However, they are designed constructed and shop-tested per the intent of ANSI N-509-1976 and ANSI N-510-1975. They are field-tested/inspected as a part of the ductwork per ANSI N-510-1980 requirements, with the applicable acceptance criteria of ANSI N-509-1980.

NOTE 10
All required in-place testing is in accordance with ANSI N-510-1980 requirements, with ANSI N-509-1980 acceptance criteria as applicable.

NOTE 11
In-place laboratory testing/inspection for activated carbon will be per ANSI N-510-1980 requirements.

NOTE 12
In lieu of the testability criteria of Section 4.11 of ANSI N-509-1976, that of Section 4.11 of ANSI N-509-1980 will be complied with.

NOTE 13
Painting is administratively controlled to protect the HEPA filters and the charcoal absorbers from the adverse effects of the fumes.

TABLE 9.5-1 NFPA STANDARDS USED FOR FIRE PROTECTION AT SEABROOK STATION

Number	Title
NFPA - 6 - 1974	Recommendation for Organization of Industrial Fire Loss Prevention
NFPA - 10 - 1981	Installation, Maintenance and Use of Portable Fire Extinguishers
NFPA - 12A - 1980	Halon 1301 Systems
NFPA - 13 - 1983	Installation of Sprinkler Systems
NFPA - 13 – 1999	Installation of Sprinkler Systems (CPS Facility Only)
NFPA - 14 - 1983	Standpipe and Hose Systems
NFPA - 15 - 1982	Water Spray Fixed Systems
NFPA - 20 - 1983	Centrifugal Fire Pumps
NFPA - 22 - 1981	Water Tanks for Private Fire Protection
NFPA - 24 - 1981	Outside Protection
NFPA - 26 - 1958	Supervision of Valves
NFPA - 27 - 1981	Private Fire Brigade
NFPA - 30 - 1981	Flammable and Combustible Liquids Code
NFPA - 31 - 1983	Oil Burning Equipment
NFPA - 37 - 1979	Stationary Combustion Engines and Gas Turbines
NFPA - 51B - 1977	Cutting and Welding Processes
NFPA - 69 - 1973	Explosion Prevention Systems
NFPA - 70 - 1975	National Electrical Code*
NFPA - 72A - 1979	Local Protective Signaling Systems
NFPA - 72D - 1979	Proprietary Protection Signaling Systems
NFPA - 72E - 1982	Automatic Fire Detectors - Installation
NFPA - 72E - 1987	Automatic Fire Detectors - Inspections, Tests and Maintenance
NFPA - 75 - 1972	Protection of Electronic Computer/DP Equipment

* As applicable to "premises wiring" of facilities outside the plant Protected Area, excluding the Fire Pumphouse.

Number	Title
NFPA - 80 - 1983	Fire Doors & Windows - Installation
NFPA - 80 - 1992	Fire Doors & Windows - Inspection and Maintenance
NFPA - 80A - 1983	Protection from Exposure Fires
NFPA - 85 - 1978	Oil & Gas Fired Water Tube Furnaces - One Burner
NFPA - 90A - 1979	Air Conditioning and Ventilation Systems
NFPA - 101 - 1981	Life Safety Code
NFPA - 204M - 1982	Smoke and Heat Venting Guide
NFPA - 220 - 1979	Building Construction, Standard Types
NFPA - 241 - 1980	Safeguarding of Building Construction and Demolition Operations
NFPA - 251 - 1979	Fire Tests of Building Construction and Materials
NFPA - 252 - 1979	Fire Tests of Door Assemblies
NFPA - 255 - 1979	Tests of Surface Burning Characteristics of Building Materials
NFPA - 256 - 1979	Fire Tests of Roof Coverings
NFPA - 321 - 1973	Classification of Flammable Liquids
NFPA - 803 - 1983	Recommended Fire Protection Practice for Nuclear Power Plants
NFPA - 1961 - 1979	Standards for Fire Hose
NFPA - 1962 - 1979	Care of Fire Hose Including Connections and Nozzles
NFPA - 1963 - 1979	Screw Threads and Gaskets for Fire Hose Connections
NFPA - 1981 - 1981	Respiratory Protective Equipment for Fire Fighters

TABLE 9.5-2 FIRE PROTECTION SYSTEMS FOR BUILDING/STRUCTURES

	Building/Structure	Fire Protection System	Type of Detection
1.	Containment	- Port. Exting. - Hose Station	- Smoke
2.	Emergency Feedwater Pump Building	- Port. Exting. - Hose Station	- Smoke
3.	Main Steam and Feedwater Pipe Enclosure	- Port. Exting. - Yard Hydrant	- Smoke - Thermal - Beam
4.	RHR, SI Equipment Vault	- Port. Exting. - Hose Station	- Smoke
5.	Control Building	- Port. Exting. - Auto. Deluge - Fixed Halon 1301 System	- Smoke - Smoke - Monitored Temp. Indication - Thermal
6.	Electrical Tunnels	- Preaction Sprinkler - Port. Exting.	- Smoke
7.	Diesel Generator Building	- Auto and Manual Preaction Sprinkler - Port Exting. - Hose Station	- Smoke - Ultraviolet - Thermal
8.	Primary Auxiliary	- Preaction Sprinkler - Hose Station - Port. Exting.	- Smoke
9.	Fuel Storage Building	- Port. Exting. - Hose Station	- Smoke - Infrared
10.	Waste Processing Building	- Port. Exting. - Hose Station	- Smoke
11.	Service Water Pumphouse	- Port. Exting. - Yard Hydrant	- Smoke

	Building/Structure	Fire Protection System	Type of Detection
12.	Service Water Cooling Tower	- Port. Exting. - Yard Hydrant	- Smoke
13.	Containment Enclosure Ventilation Area	- Port. Exting. - Hose Station - Yard Hydrant	- Smoke
14.	Fire Pumphouse	- Port. Exting. - Wet Pipe Sprinkler System	- Thermal & Smoke
15.	Turbine Building (Includes Radio Room)	- Wet Pipe Sprinkler System Port. Exting. - Hose Station	- Smoke (in Computer Room and Battery Rooms). - Thermal (at Turbine Generator Bearings, Lube Oil Piping and Portable Air Compressor).
16.	Mechanical Penetration Area	- Port. Exting. - Hose Station	- Smoke
17.	Nonessential Switchgear Room	- Port. Exting. - Yard Hydrant	- Smoke
18.	Lube Oil Storage Building	- Wet Pipe Sprinkler System	- None
19.	Condensate Polisher Facility	- Wet Pipe Sprinkler System - Hose Station - Port. Exting.	- Thermal

NOTE: This listing does not include the Administration Building, RCA Storage Facility, Supplemental Emergency Power System, Guard House, Alternate RP Checkpoint and Office Building(s) within the protected area.

TABLE 9.5-3 FIRE PROTECTION SYSTEM FAILURE MODES AND EFFECTS ANALYSIS

System	Type Of Failure	Method Of Direction	Result Of Failure	Adverse Effect	Method Of Recovery
Motor Driven Pump	Pump fails to start (Fire) or stops running (Fire)	Motor fails to start or motor trip alarm	Pump does not supply water to yard loop	None	Lead diesel engine-driven Fire Pump starts if main pressure does not increase after 10 seconds
Lead Diesel Driven Fire Pump	Pump fails to start (Fire) or stops running (Fire	Engine fails to start or engine trip alarm	Pump does not supply water to yard loop	None	Second engine-driven pump starts if main pressure does not increase after 20 seconds
Fire Protection Loop	Pipe rupture (No Fire)	Fire pump starts with no fire alarm and no water flow or deluge valve trip alarm	Water flows at break	None	Use post indicating valves to isolate damaged section. Configuration ensures continued supply to remaining sections
	Pipe rupture (Fire)	Drop in system pressure or visual detection	Reduced flow at actuated system or hose nozzle	None	Isolate damaged section or standpipe

System	Type Of Failure	Method Of Direction	Result Of Failure	Adverse Effect	Method Of Recovery
Wet Standpipe Systems (in Turb. Bldg. and Admin. Serv. Bldg.)	Pipe rupture (No Fire)	Water flow alarm for each system	Water flows at break	None	Isolate branch or standpipe as necessary.
	Pipe rupture (No Fire)	Visual	Water flows at break does not flow from hose nozzle	None	Isolate branch or standpipe. Use alternate hose station, or portable fire extinguishers.
Automatic Sprinkler Systems (in Turb. Bldg. and Admin. Serv. Bldg.)	Pipe rupture (No Fire)	Water flow alarm for each system	Water flows at break	None	Isolate system
	Pipe rupture (Fire)	Visual	Water flows at break. Loss of water at sprinkler heads	Possible loss of Equipment	Isolate System. Use fire hoses, or portable fire extinguishers
	Sprinkler head opens (No Fire)	Water flow alarm for each system	Water flows from sprinkler head	None	Isolate system
	Sprinkler head fails to open (Fire)	No flow alarm after fire alarms	Water does not flow from sprinkler head	None	Adjacent heads open. Use fire hoses, or portable fire extinguishers

System	Type Of Failure	Method Of Direction	Result Of Failure	Adverse Effect	Method Of Recovery
Water Spray Preaction Valve System (DG Bldg. Cable Spread Area, Deluge Station Transformers)	Pipe rupture (No Fire)	Visual periodic inspection	None	None	Isolate system
	Pipe rupture (Fire)	Deluge valve flow alarm not actuated	Water flows at break. Loss of water at spray nozzles	Possible loss of equipment	Isolate system. Use fire hoses or portable fire extinguishers.
	Deluge valve fails to open (Fire)	Deluge valve "open" alarm not actuated	No system discharge	Slight delay in fire fighting	Manually actuate valve
	Deluge valve opens (No Fire)	Water Flow alarm. No fire alarm	Water discharges from nozzles	None	Manually reset deluge valve
	Detector alarm (No Fire)	Fire alarm	Deluge valve is opened	None	Isolate malfunctioning circuit
	Detector Fails to alarm (Fire)	Periodic test	None	None	Other adjacent detectors will actuate the valve

System	Type Of Failure	Method Of Direction	Result Of Failure	Adverse Effect	Method Of Recovery
Preaction Sprinkler System (Electric Tunnels)	Pipe rupture (No Fire)	"Loss of Air Pressure" alarm	Supervisory air pressure released	None	Isolate system
	Pipe rupture (Fire)	Visual	Water flows at break, loss of water at sprinkler heads	None	Isolate system. Use fire hose or portable fire extinguisher
	Sprinkler head opens (No Fire)	"Loss of Air Pressure" alarm for system	Supervisory air pressure in system is released	None	Isolate system
	Sprinkler head fails to open (Fire)	Visual	Water does not flow from head	None	Adjacent heads open
	Dry pipe valve fails to open (Fire)	Water flow alarm not actuated	No discharge from system	Slight delay in fire fighting	Open valve manually
	Detector alarms (No Fire)	Fire alarm	Deluge valve actuated	None; Water will not flow until heads actuate	Isolate malfunctioning circuit
	Detector fails to alarm(Fire)	Periodic test	None	None	Adjacent detectors will alarm
Portable Extinguisher	Extinguisher fails to discharge (Fire)	Visual	None	None	Use other extinguishers

System	Type Of Failure	Method Of Direction	Result Of Failure	Adverse Effect	Method Of Recovery
Loss of Plant Fire Water System	Water tanks ruptured or loss of fire pumps due to seismic event	Drop in system pressure or visual detection	No flow at standpipe hose stations	None	Open valve in plant service water backup system supplying water to standpipe systems serving safety-related structures and systems.

TABLE 9.5-4 DIESEL GENERATOR FUEL OIL STORAGE AND TRANSFER SYSTEM EQUIPMENT DATA

Fuel Oil Storage Tank	
Number	One per DG Set
Size	20'-0x28'
Design Capacity, gal.	75,000
Full Capacity, gal.	76,425
Design Pressure, psig	15
Design Temperature, °F	100
Materials	Carbon Steel SA-283C
Fuel Oil Day Tank	
Number	One per DG Set
Size	4'-0x16'-4"
Design Capacity, gal.	1500
Full Capacity, gal.	1582
Design Pressure, psig	15
Materials	Carbon Steel SA-515-70
Fuel Oil Storage Tank Transfer Pump	
Number	One per DG Set
Capacity, gpm	20
Discharge Head, ft	50
Source of Power	EDE-MCC-521 (A) EDE-MCC-621 (B)
Motor, hp	2
Voltage	460
Phase/Frequency	3/60

On-Skid Auxiliary Fuel Oil Pump

Number	One per DG Set
Capacity, gpm	13.7
Discharge Pressure, psig	35
Source of Power	EDC-MCC-511 (A) EDC-MCC-611 (B)
Motor, hp	2
Voltage	460
Phase/Frequency	3/60

TABLE 9.5-5 DIESEL GENERATOR FUEL OIL STORAGE AND TRANSFER SYSTEM FAILURE MODE AND EFFECTS ANALYSIS

Component	Function (Operating Mode)	***Failure Mode***	Failure Mechanism	***Effect on System***	Method of Failure Detection
Transfer Pump	Pump fuel to day tank	No fuel flow	(1) Motor fails	None: Use pump for redundant operating diesel	Level Alarm
			(2) Pump fails	None: Use pump for redundant operating diesel	Level Alarm
			(3) Loss of power	None: Use redundant diesel	Level Alarm

TABLE 9.5-6 DIESEL GENERATOR COOLING WATER SYSTEM EQUIPMENT DATA

MAIN HEAT EXCHANGER	
Number	One per DG Set
Shellside Fluid	Jacket Cooling Water
Tubeside Fluid	Service Water
Shellside Design Pressure, psig	150
Tubeside Design Pressure, psig	150
Shellside Design Flow, gpm	1305
Tubeside Design Flow, gpm	1800
Shell Material	Carbon Steel, SA-106B
Tube Material	90/10 CuNi, SB-111
Jacket Coolant Pump	
Number	One per DG Set
Design Capacity, gpm	1050
Drive	Diesel engine
Air Cooler Pump	
Number	One per DG Set
Design Capacity, gpm	1060
Drive	Diesel engine
Auxiliary Coolant Pump	
Number	One per DG Set
Capacity, gpm	1150
Discharge Head, ft	110
Source of Power	EDE-MCC-511 (A) EDE-MCC-611 (B)
Motor, hp	50
Voltage	460
Phase/Frequency	3/60

Standby Circulating Pump	
Number	One per DG Set
Capacity, gpm	70
Discharge Head, ft	20
Source of Power	EDE-MCC-511 (A) EDE-MCC-611 (B)
Motor, hp	1
Voltage	460
Phase/Frequency	3/60
Expansion Tank	
Number	One per DG Set
Size	3'-0x6'
Design Capacity, gal.	290
Design Pressure, psig	15
Materials	Carbon Steel, SA-515-70
Jacket Water Heater	
Source of Power	EDE-MCC-511 (A) EDE-MCC-611 (B)
Power, kW	49
Voltage	460
Phase/Frequency	3/60

TABLE 9.5-7 DIESEL GENERATOR LUBRICATION SYSTEM EQUIPMENT

Lube Oil Heat Exchanger

Number	One per DG set	
Design Data:	Tubeside	Shellside
Fluid	Cooling water	Lube Oil
Flow, gpm	1060	475
Inlet Temp. °F	120.9	160.0
Outlet Temp. °F	124.9	141.6
Pressure, Psig	150	150
Tube Material	Admiralty SB-111	
Shell Material	Carbon Steel SA-106-B	

Lube Oil Pump

Number	One per DG Set
Design Capacity, gpm	475
Drive	Diesel Engine

Auxiliary Lube Oil Pump

Number	One per DG Set
Capacity, gpm	475
Discharge Head, psi	100
Source of Power	EDE-MCC-511 (A) EDE-MCC-611 (B)
Motor, hp	60
Voltage	460
Phase/Frequency	3/60

Engine Prelube and Filter Pump

Number	One per DG Set
Capacity, gpm	75
Discharge Head, psi	140
Source of Power	EDE-MCC-511 (A) EDE-MCC-611 (B)
Motor, hp	15
Voltage	460
Phase/Frequency	3/60

Rocker Arm Prelube Pump

Number	One per DG Set
Capacity, gpm	2.4
Discharge Head, psi	20
Source of Power	EDE-MCC-511 (A) EDE-MCC-611 (B)
Motor, hp	0.5
Voltage	460
Phase/Frequency	3/60

TABLE 9.5-8 DIESEL GENERATOR COMBUSTION AIR INTAKE AND EXHAUST SYSTEM FAILURE MODE AND EFFECTS ANALYSIS

Component	Function (Operating Mode)	***Failure Mode***	Failure Mechanism	Method of Failure Effect on System	***Detection***
Air Intake Filter	Filters combustion air	No air flow	Filter clogged	None - Use redundant diesel	Engine fails to start/run; air pressure alarm
Exhaust Silencer	Reduce noise	No exhaust flow	Silencer clogged	None - Use redundant diesel	Engine fails to start/run
Crankcase Exhauster	Positive crankcase ventilation	No exhaust flow	1. Motor fails	None	Crankcase pressure alarm
			2. Exhauster fails	None	Crankcase pressure alarm
			3. Loss of power	None	Crankcase pressure alarm

TABLE 9.5-9 (DELETED)

SEABROOK STATION
UPDATED FINAL SAFETY ANALYSIS REPORT

CHAPTER 9
AUXILIARY SYSTEMS

FIGURES

See PID-1-SF-B20480

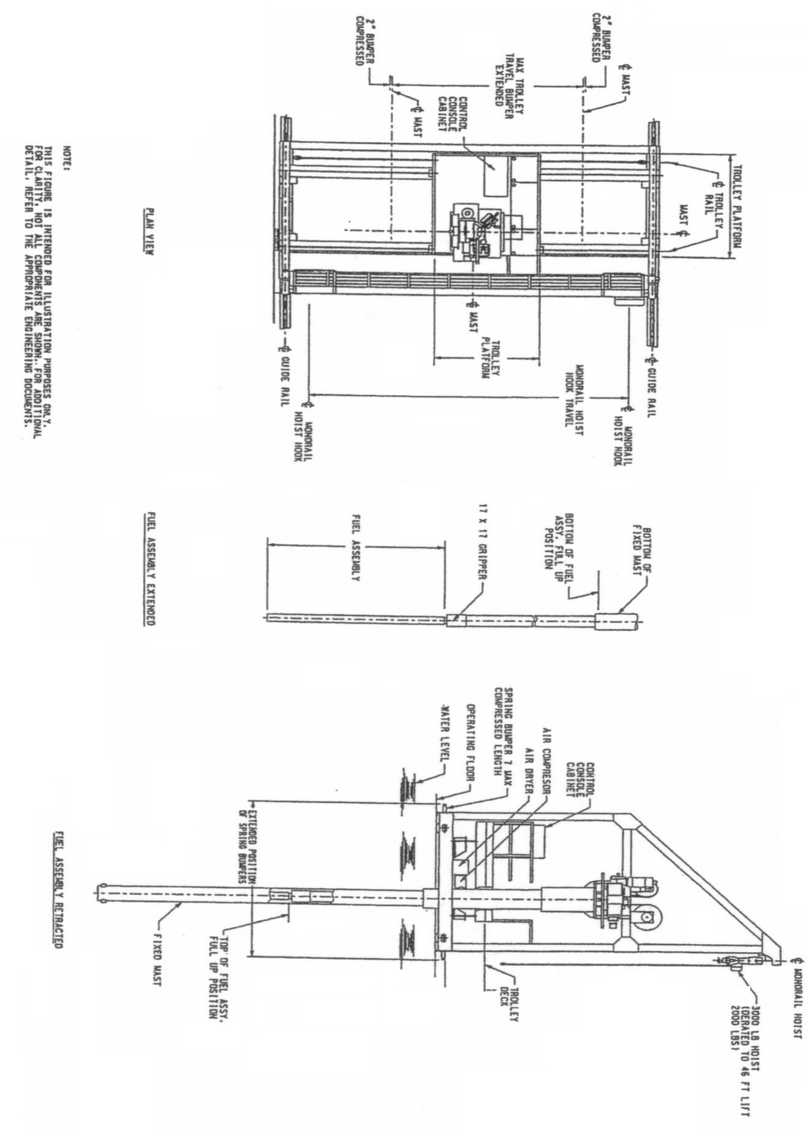
SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Spent Fuel Pool Cooling and Cleanup System Overview	
		Figure 9.1-1

See PID-1-SF-B20482

See PID-1-SF-B20483

See PID-1-SF-B20484

SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Spent Fuel Pool Cooling and Cleanup System Detail	
		Figure 9.1-2 Sh. 3 of 3



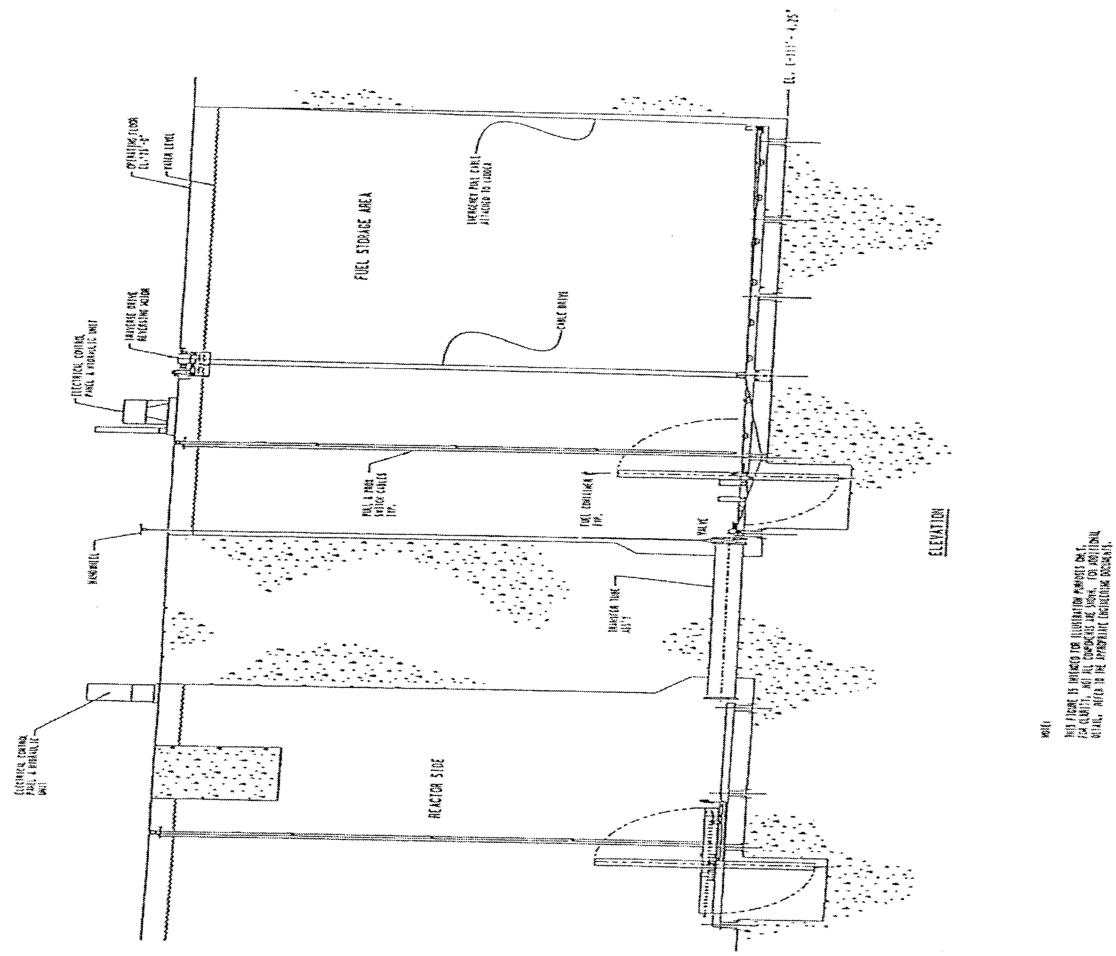
SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Illustration Refueling Machine	
		Figure 9.1-3

See FP-B55944

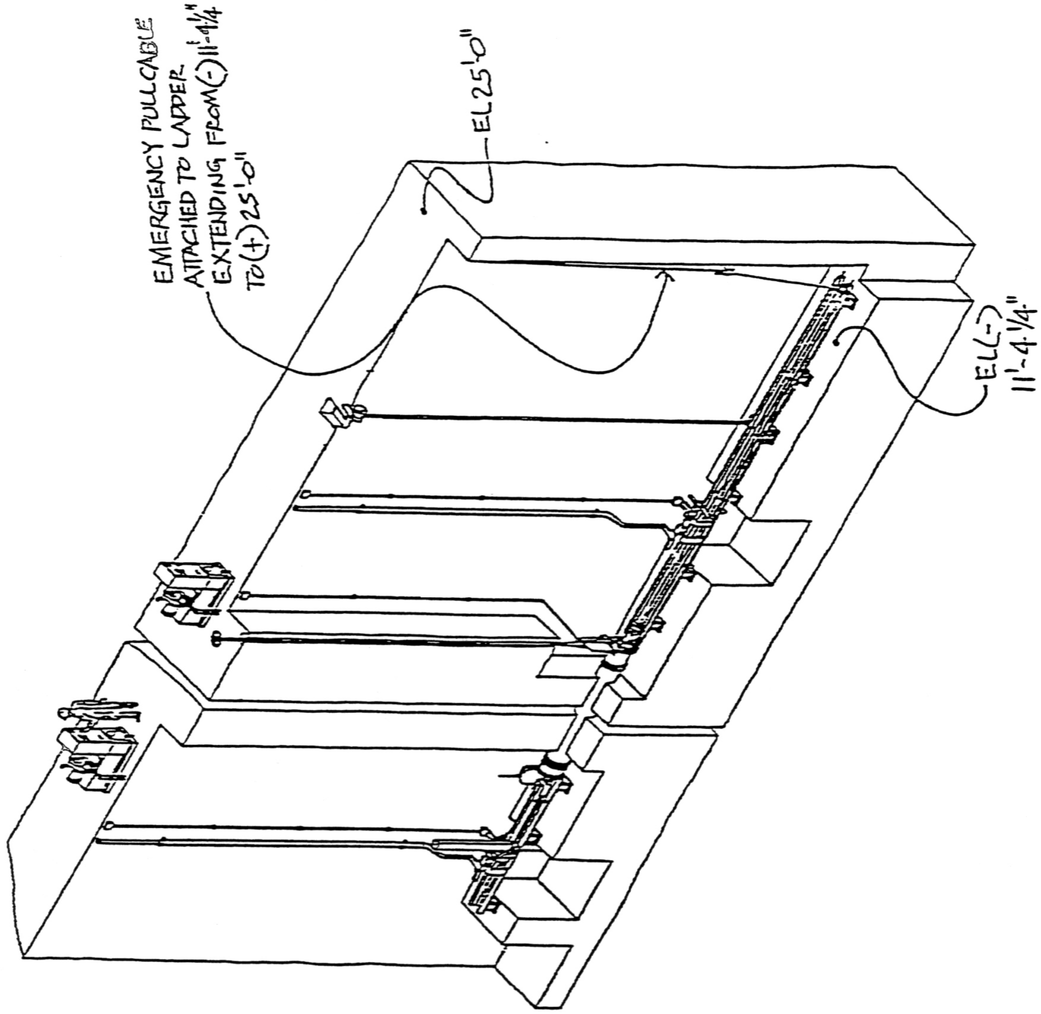
SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	New Fuel Elevator Arrangement	
		Figure 9.1-4

See FP-B55944

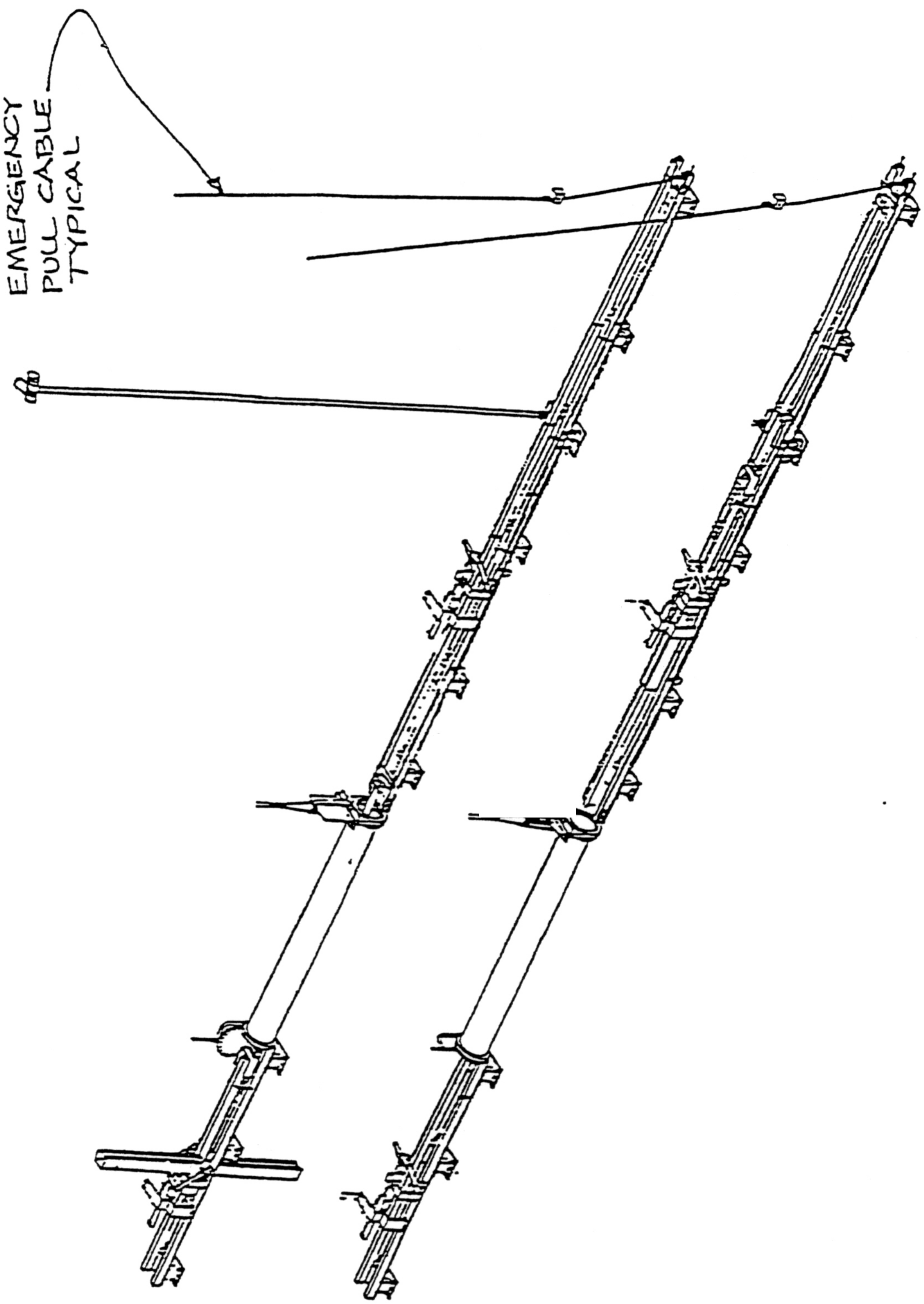
SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	New Fuel Elevator Track Arrangement	
		Figure 9.1-5



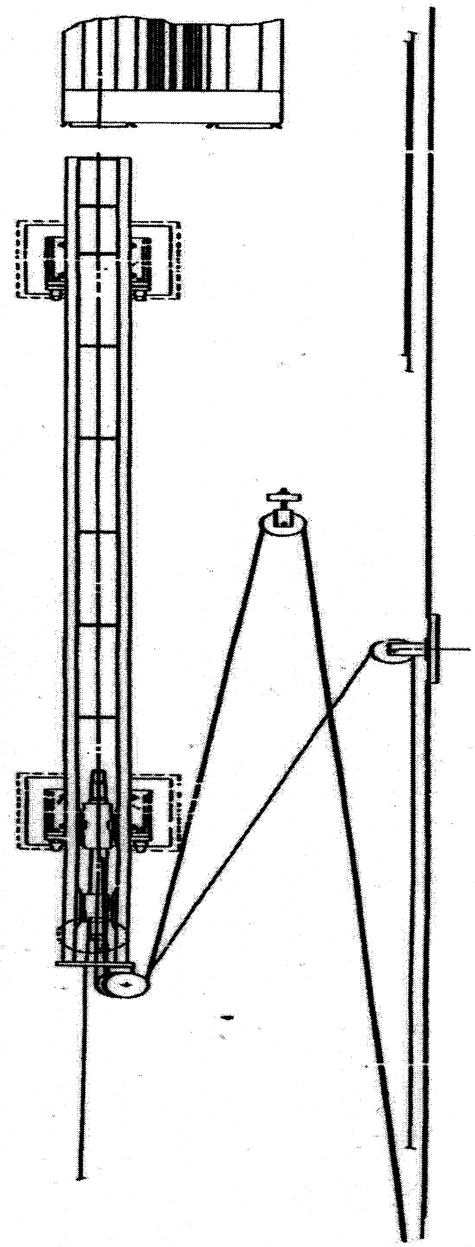
SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Illustration Refuel Transfer System
	Figure 9.1-6 Sh. 1 of 3

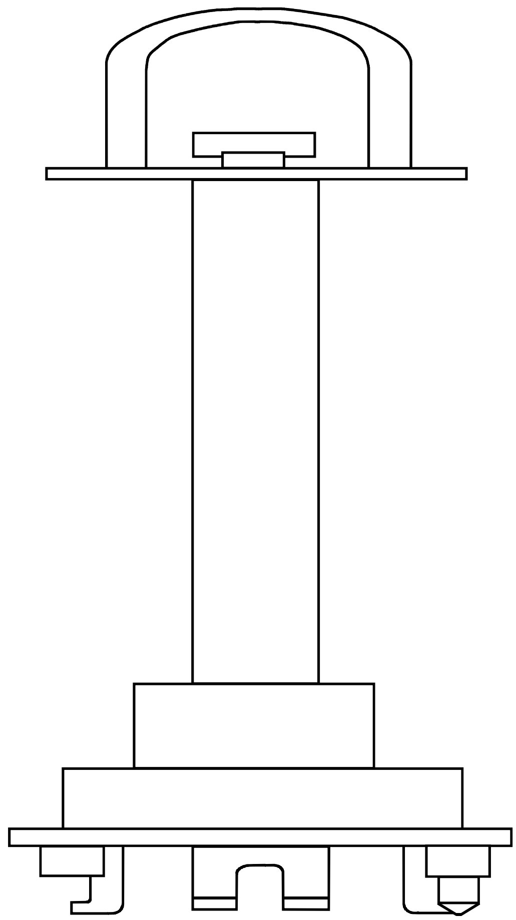


SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Illustration Refuel Transfer System
	Figure 9.1-6 Sh. 2 of 3



SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Illustration Refuel Transfer System	
		Figure 9.1-6 Sh. 3 of 3





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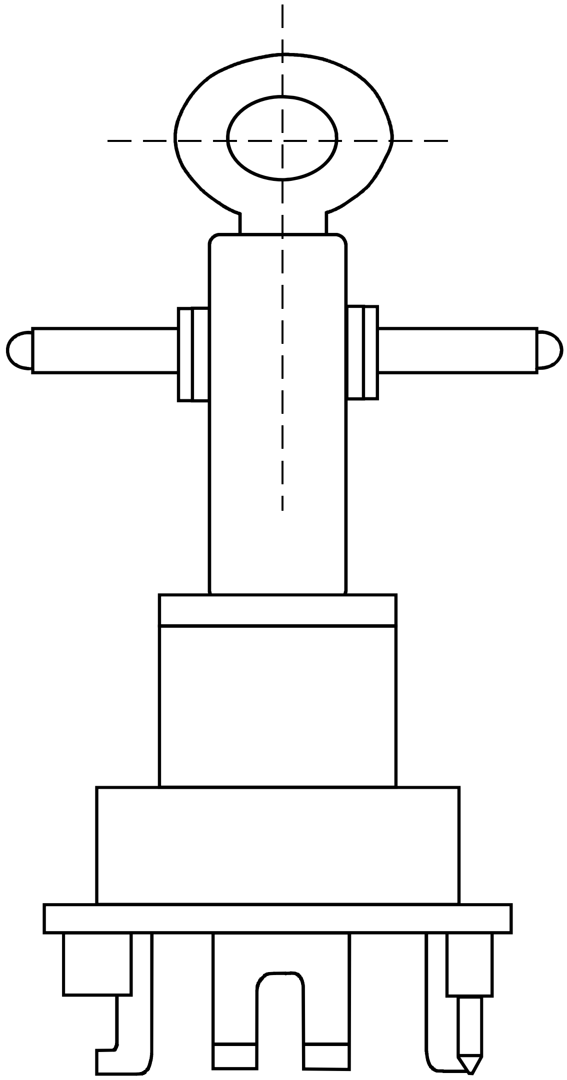
SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Spent Fuel Handling Tool	
		Figure 9.1-8



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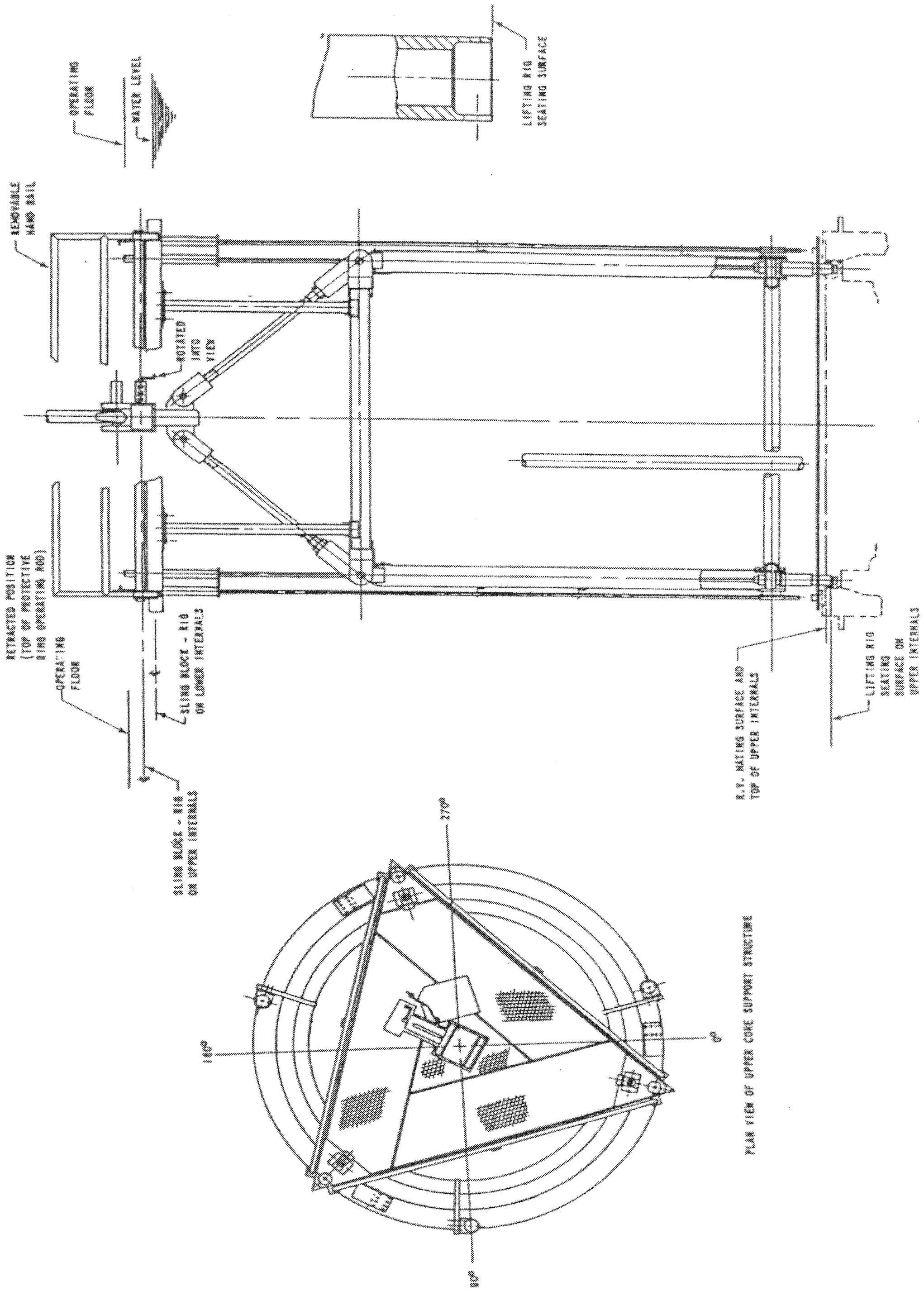
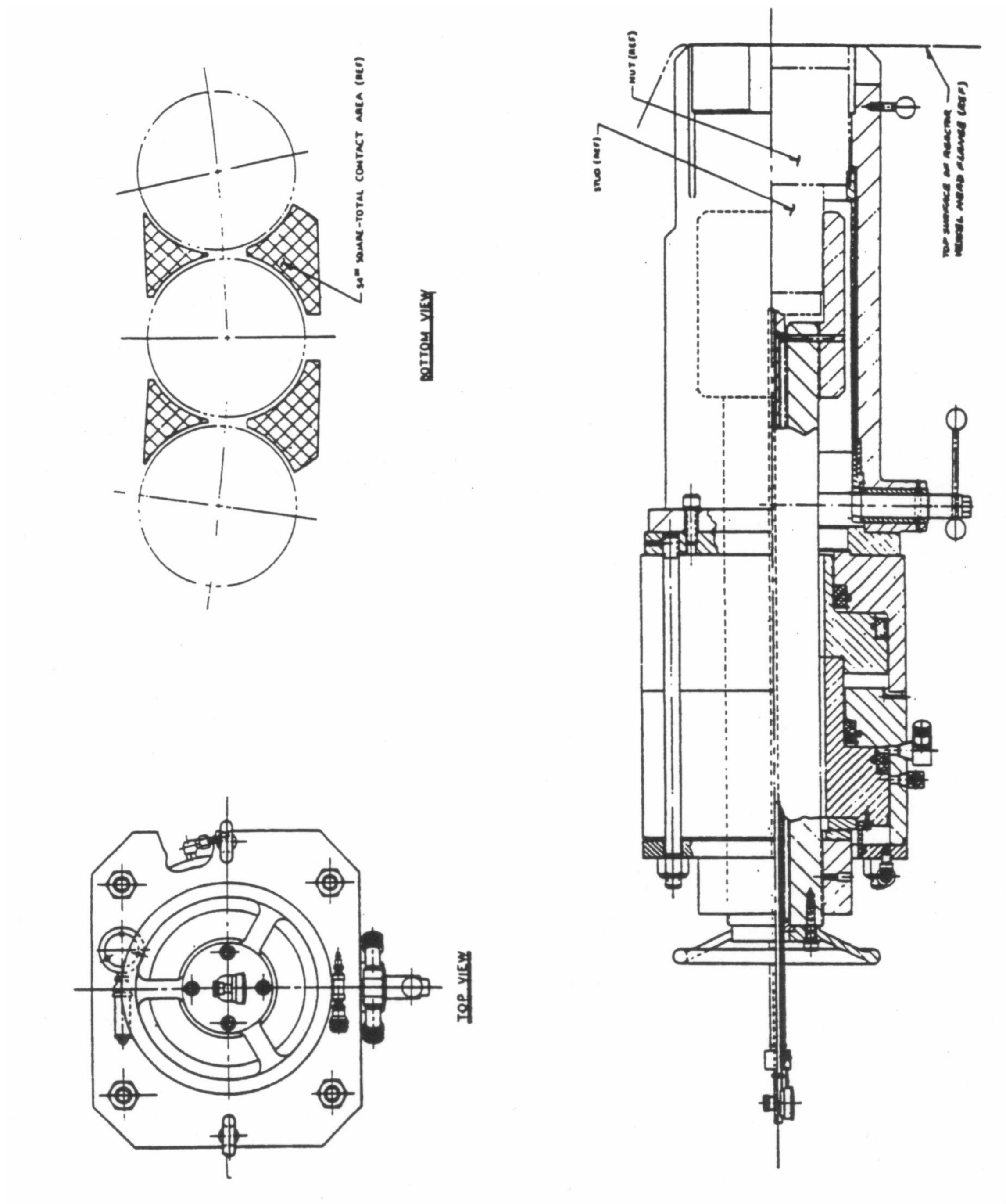
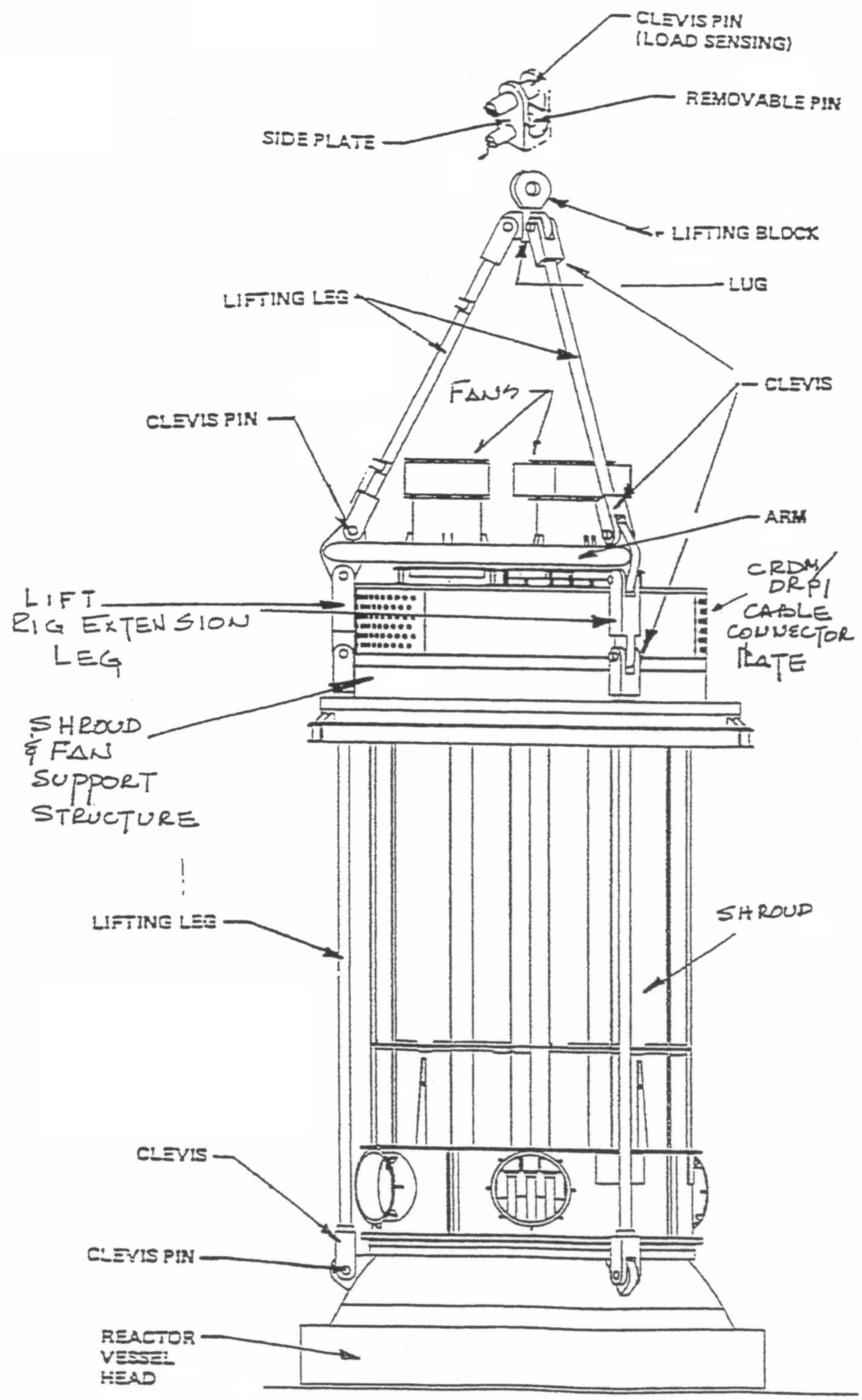


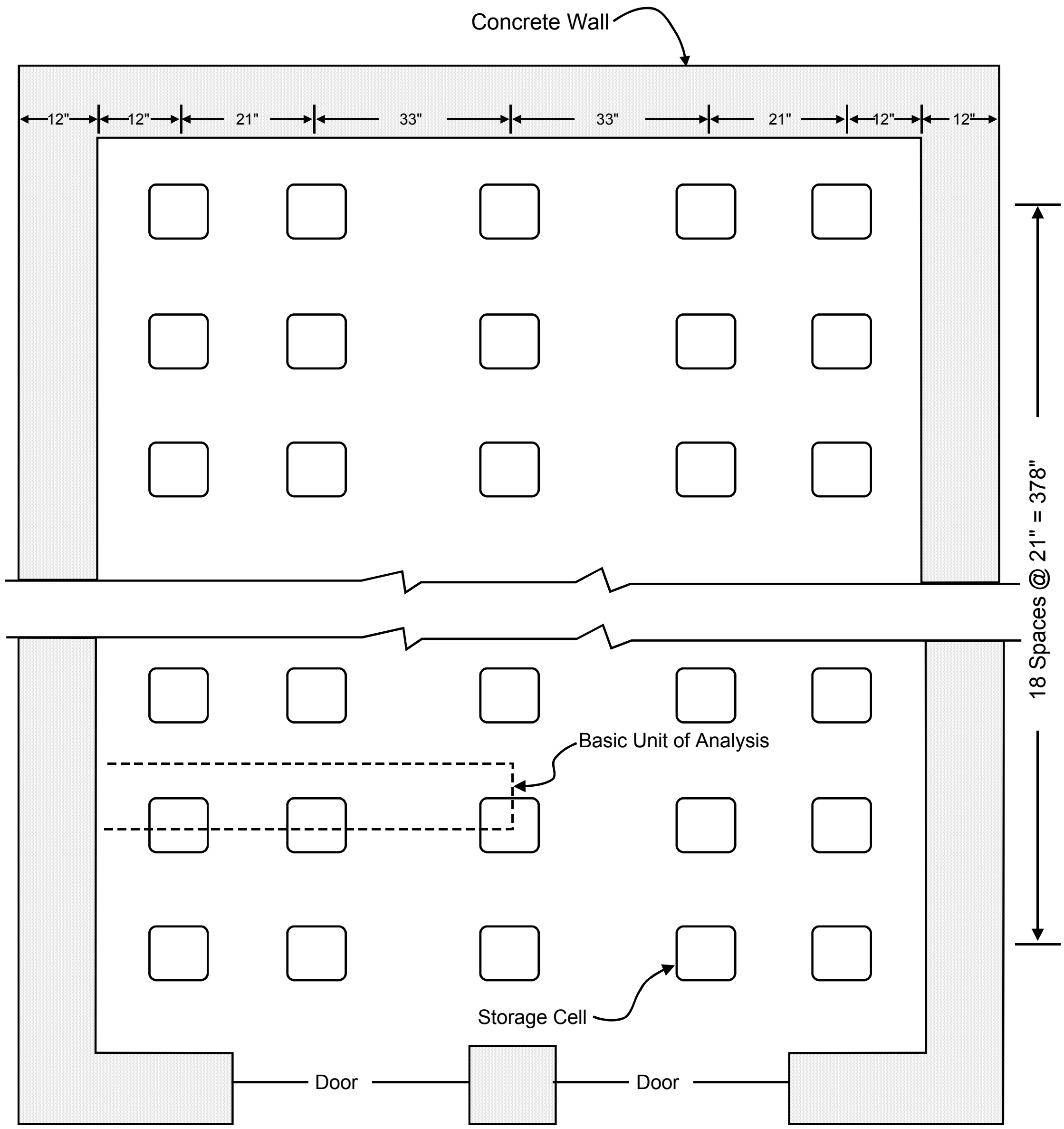
SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Upper Core Barrel Handling Fixture	
		Figure 9.1-10



SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Stud Tensioner
	Figure 9.1-11



SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Reactor Vessel Head Lifting Rig	
		Figure 9.1-12



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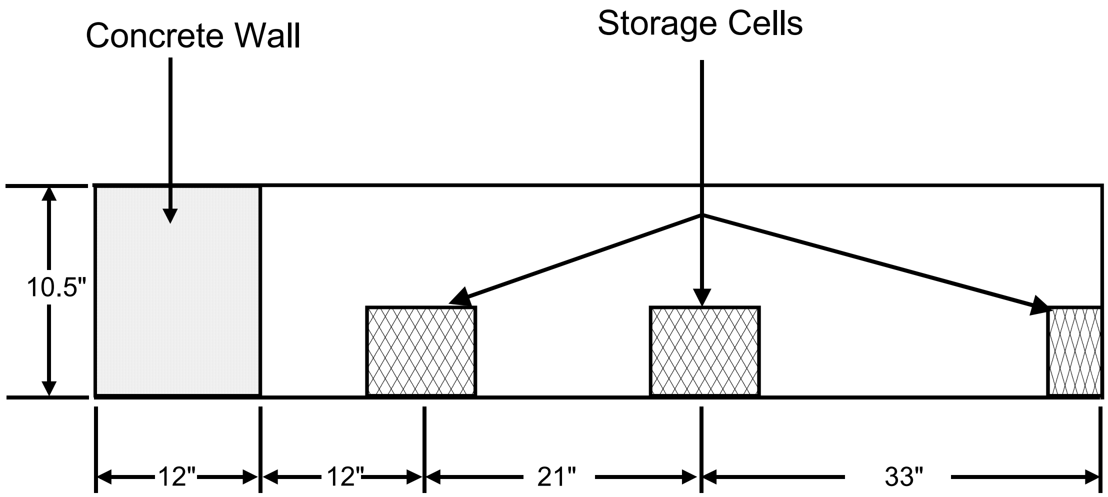
SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Seabrook Station New Fuel Vault	
		Figure 9.1-13



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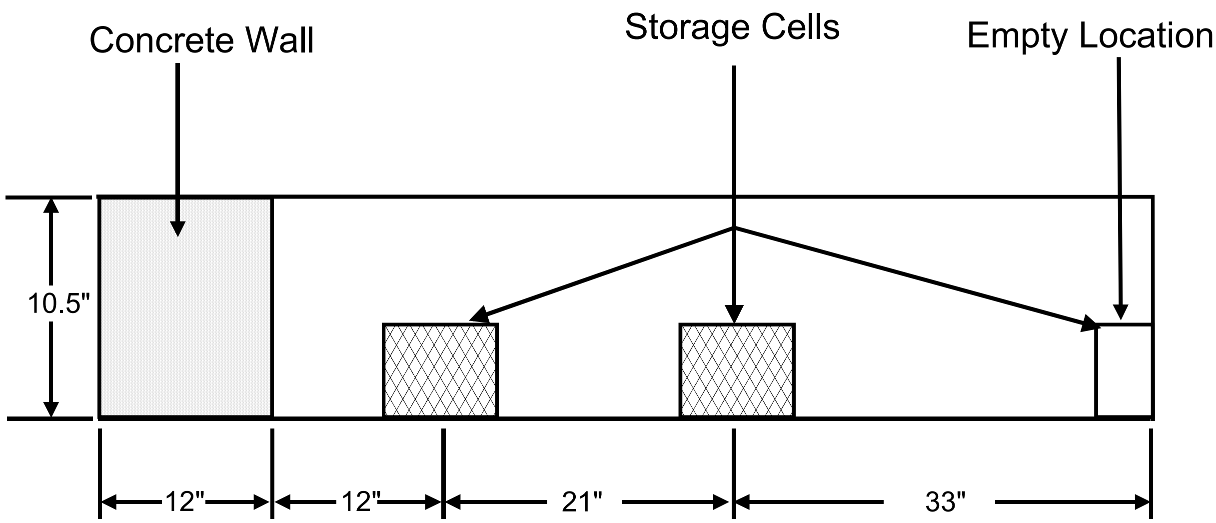
SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Fully Loaded New Fuel Vault KENO-Va Model	
		Figure 9.1-14



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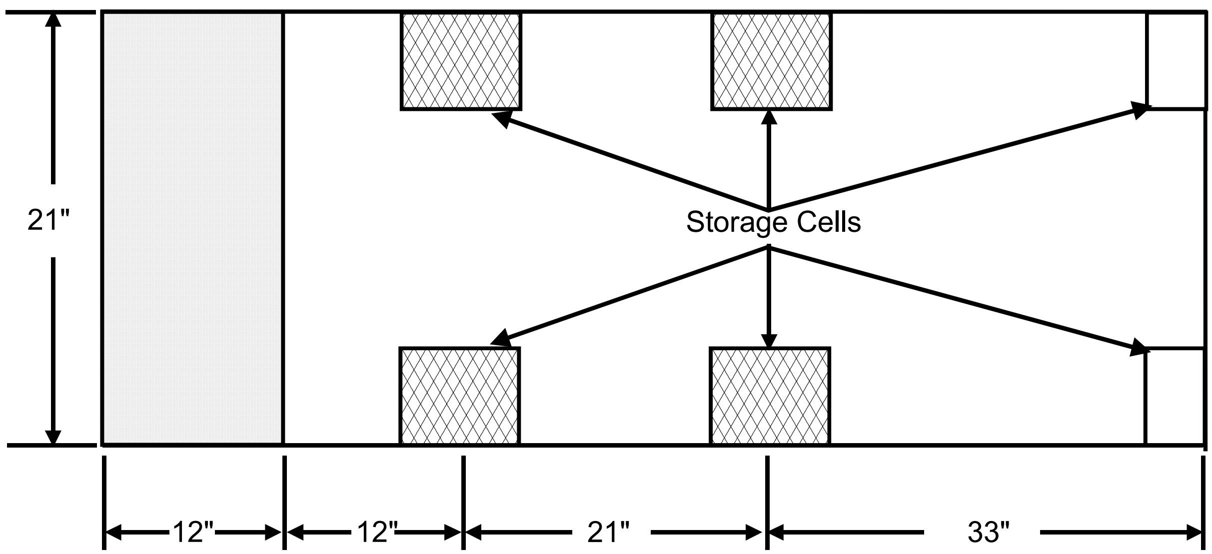
Partially Loaded, 72 Assembly Capacity, New Fuel Vault KENO-Va Model



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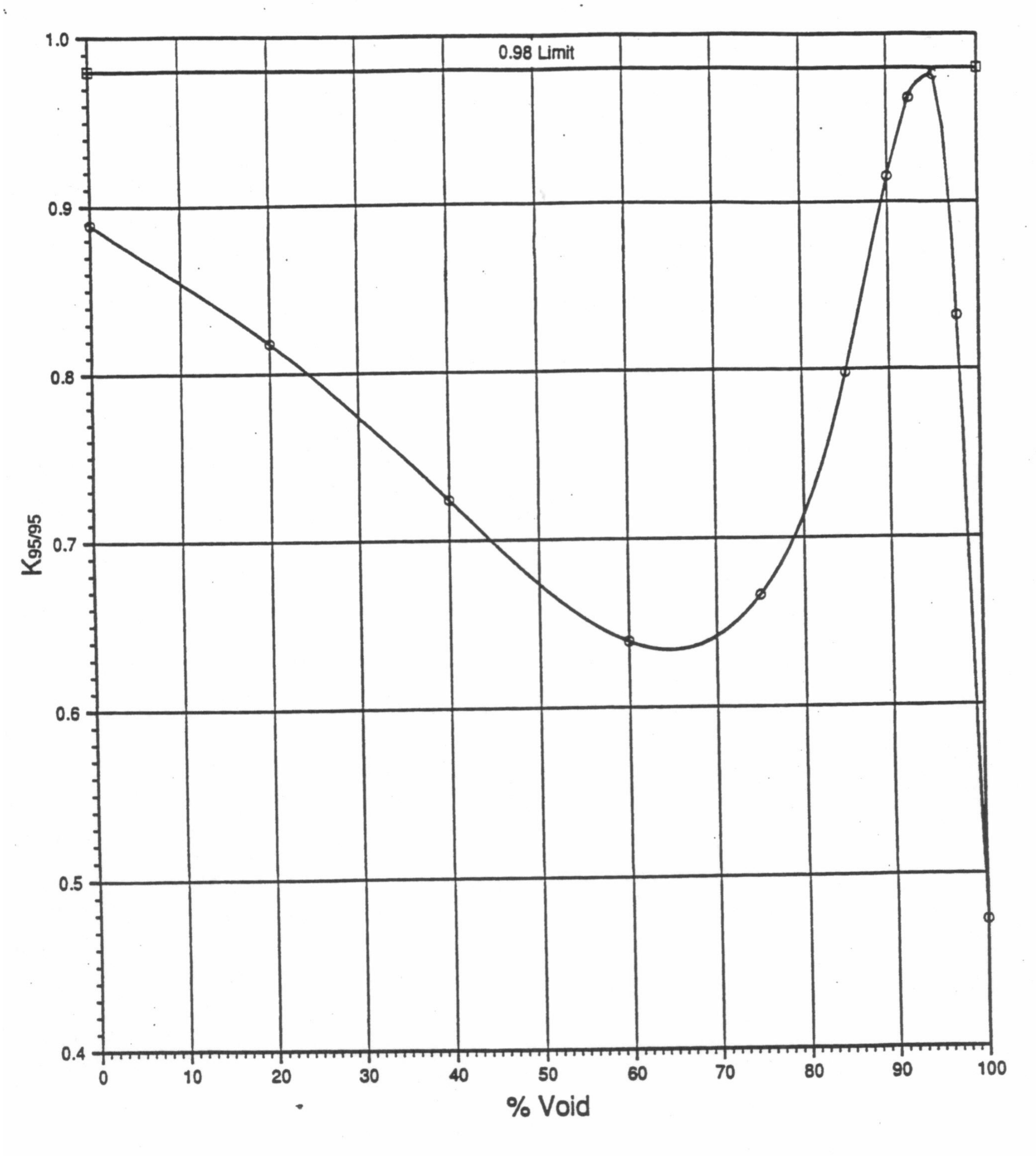
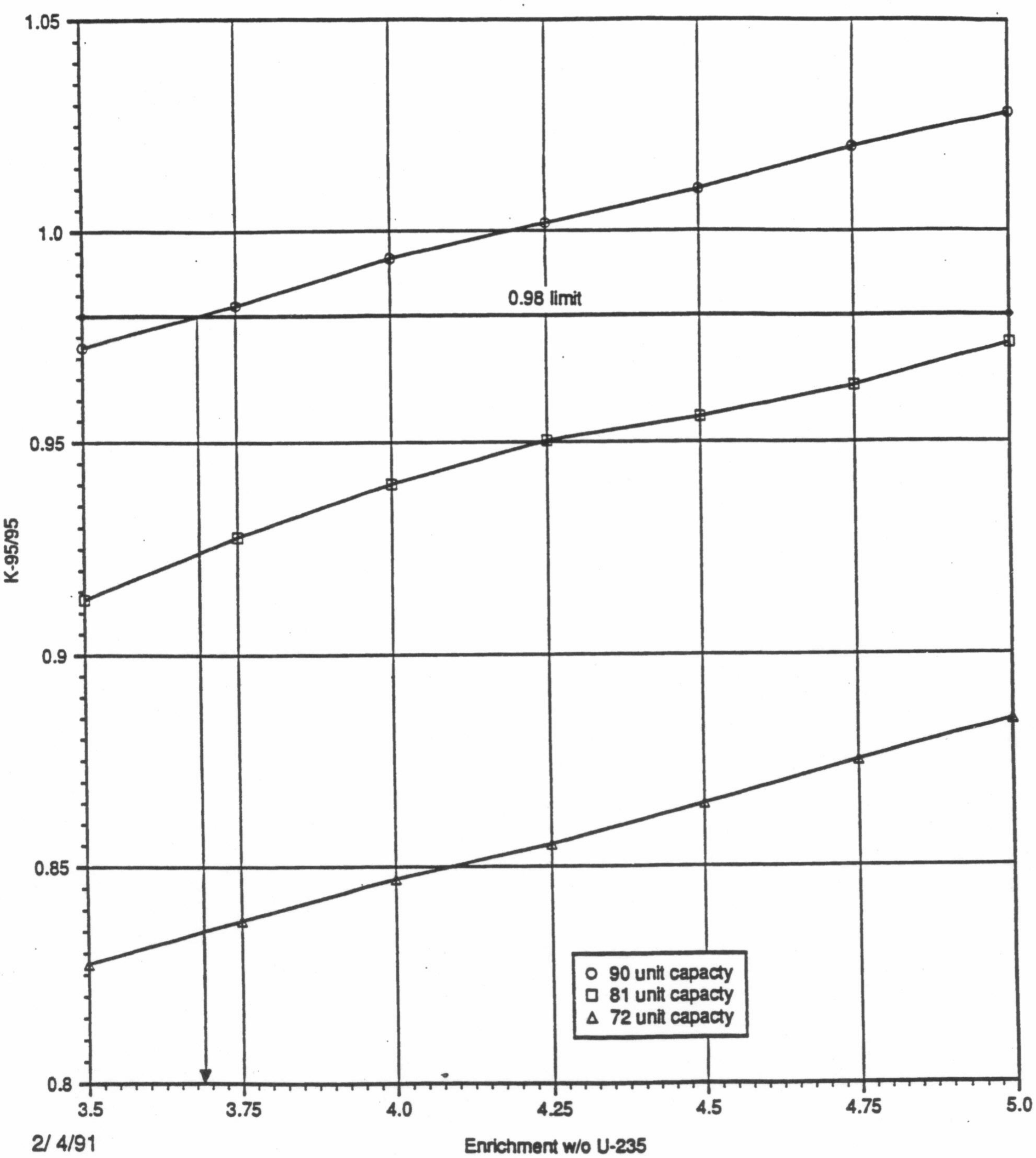
SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Partially Loaded, 81 Assembly Capacity, New Fuel Vault KENO-Va Model
	Figure 9.1-16

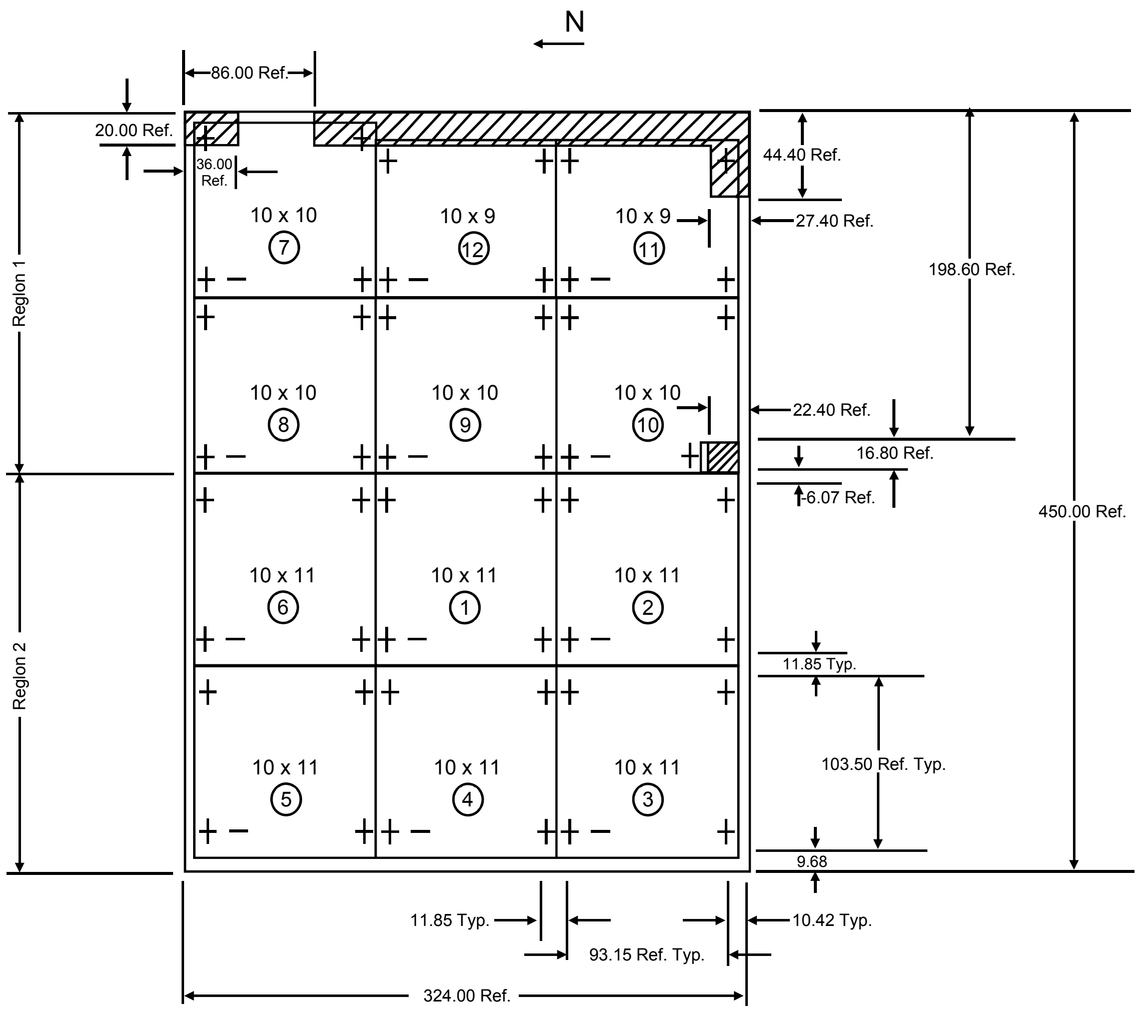


New Fuel Vault $K_{95/95}$ vs. Void, Fully Loaded with 3.5 w/o ^{235}Fuel

Figure 9.1-17



SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	New Fuel Vault $K_{95/95}$ vs. Enrichment and Vault Loading at "Optimum Moderation"	
		Figure 9.1-18



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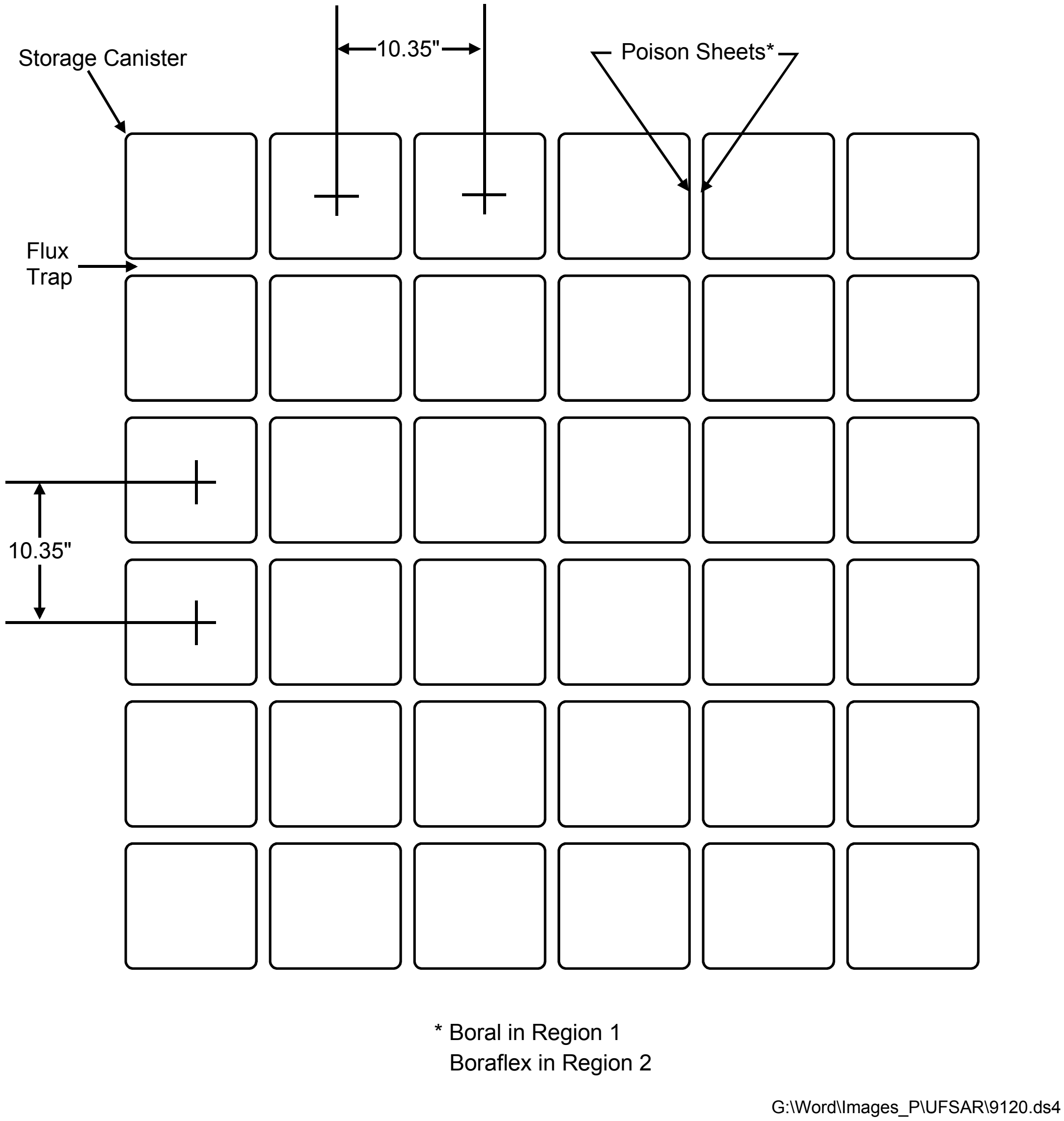
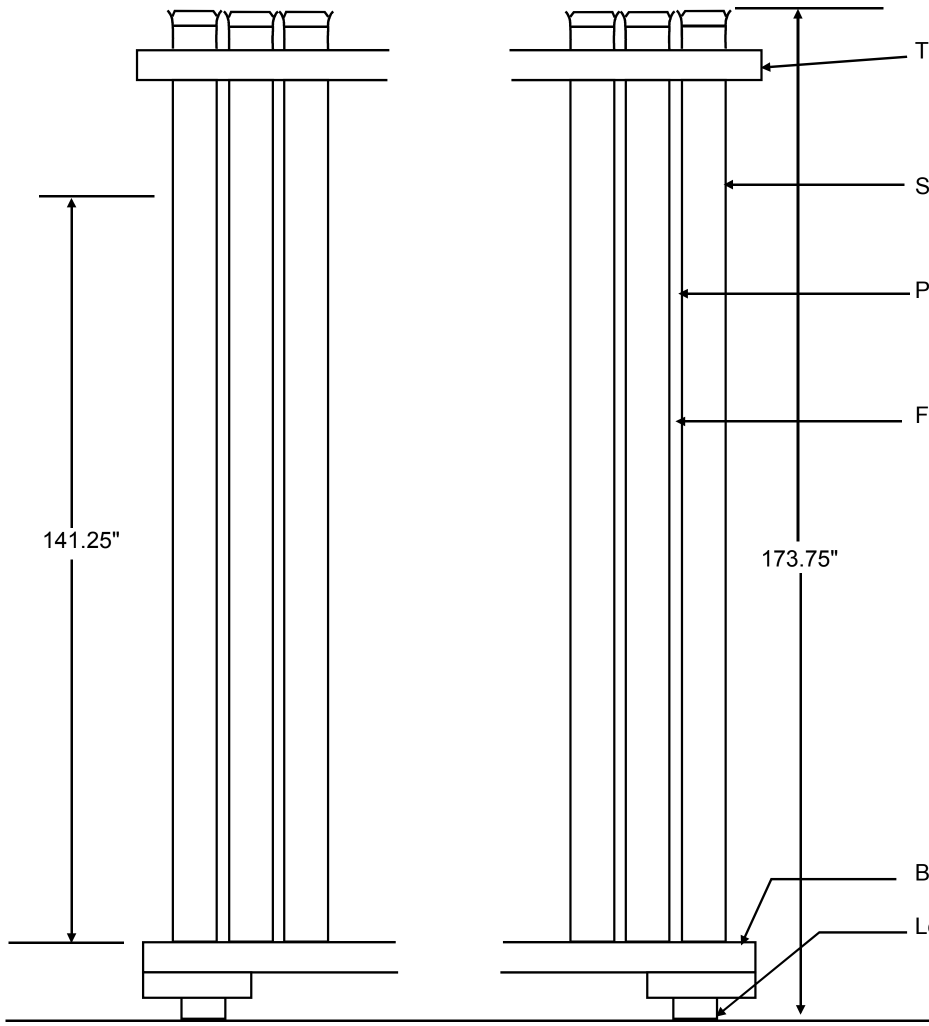
SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Seabrook Station Spent Fuel Pool	
		Figure 9.1-19



Storage Rack Module, Radial

Figure 9.1-20



*Boral in Region 1
Boraflex in Region 2

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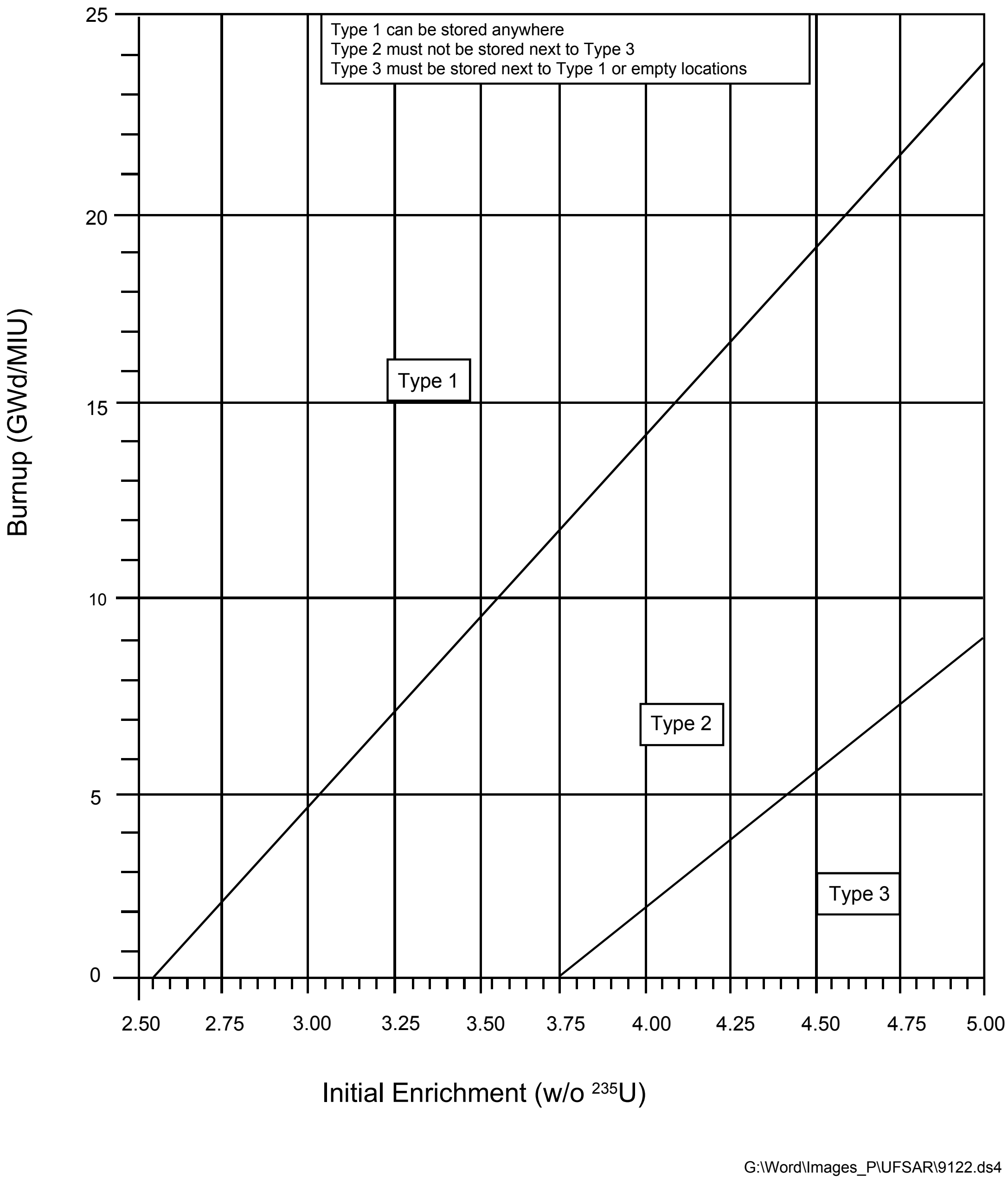
SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Storage Rack Module, Axial	
		Figure 9.1-21



SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Storage Rack Burnup Credit and Checkerboard Technical Specification
	Figure 9.1-22

Figure 9.1-23
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Figure 9.1-24
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Figure 9.1-25
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Figure 9.1-26
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Figure 9.1-27
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Figure 9.1-28
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See PID-1-SW-B20792

See PID-1-SW-B20794

SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Service Water System Nuclear Detail [3 sheets]
	Figure 9.2-2 Sh. 1 of 3

See PID-1-SW-B20795

See PID-1-SW-B20796

See PID-1-CC-B20204

SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Primary Component Cooling Loop A Overview	
		Figure 9.2-3

See PID-1-CC-B20205

See PID-1-CC-B20206

See PID-1-CC-B20207

See PID-1-CC-B20208

See PID-1-CC-B20210

SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Primary Component Cooling Loop B Overview	
		Figure 9.2-5

See PID-1-CC-B20211

Primary Component Cooling Loop B Detail

Figure 9.2-6 Sh. 1 of 5

See PID-1-CC-B20212

SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Primary Component Cooling Loop B Detail	
		Figure 9.2-6 Sh. 2 of 5

See PID-1-CC-B20213

SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Primary Component Cooling Loop B Detail	
		Figure 9.2-6 Sh. 3 of 5

See PID-1-CC-B20214

SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Primary Component Cooling Loop B Detail	
		Figure 9.2-6 Sh. 4 of 5

See PID-1-CC-B20215

SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Primary Component Cooling Loop B Detail	
		Figure 9.2-6 Sh. 5 of 5

See PID-1-DM-B20348

SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Demineralized Water Distribution System Overview	
		Figure 9.2-7

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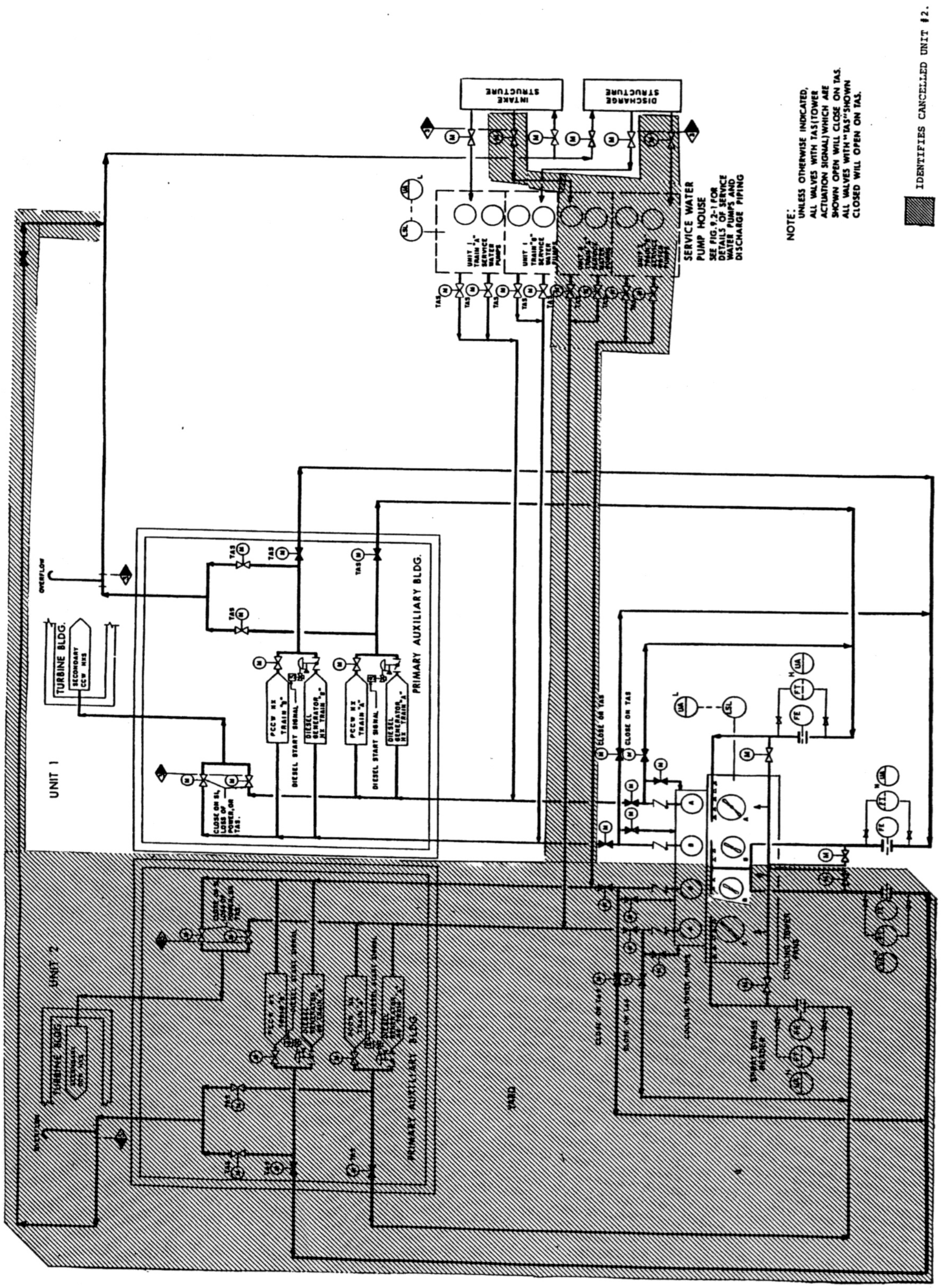
See PID-1-PW-B20914

SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Potable Water Overview [2 sheets]	
		FIGURE 9.2-9 Sh. 1 of 2

See PID-1-PW-B20915

SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Potable Water Overview [2 sheets]	
		FIGURE 9.2-9 Sh. 2 of 2



SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Ultimate Heat Sink
	Figure 9-2-10

See PID-1-RMW-B20360

See 1-NHY-202499

SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Service Water System - Yard-Key Plan Piping	
		Figure 9.2-12

See PID-1-CC-B20209

Primary Component Cooling Thermal Barrier Loop Detail

Figure 9.2-13

Figure 9.2-14
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See PID-1-DM-B20349

SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Demineralized Water Distribution System Turbine Bldg	
		Figure 9.2-15

See PID-1-IA-B20636

See PID-1-IA-B20637

SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Instrument Air Turbine Building Detail	
		Figure 9.3-2 Sh. 1 of 3

See PID-1-IA-B20638

See PID-1-IA-B20639

See PID-1-IA-B20640

See PID-1-IA-B20641

See PID-1-IA-B20643

Instrument Air Containment Building Detail

Figure 9.3-5

See PID-1-IA-B20644

See PID-1-IA-B20645

See PID-1-IA-B20646

See PID-1-IA-B20647

SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Instrument Air Miscellaneous Buildings Detail [4 sheets]	
		Figure 9.3-6 Sh. 4 of 4

See PID-1-SA-B20649

See PID-1-SA-B20650

SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Service Air System Turbine Building Detail	
		Figure 9.3-8

See PID-1-SA-B20651

See PID-1-SA-B20652

See PID-1-SA-B20653

See PID-1-SS-B20516

See PID-1-SS-B20518

See PID-1-SS-B20519

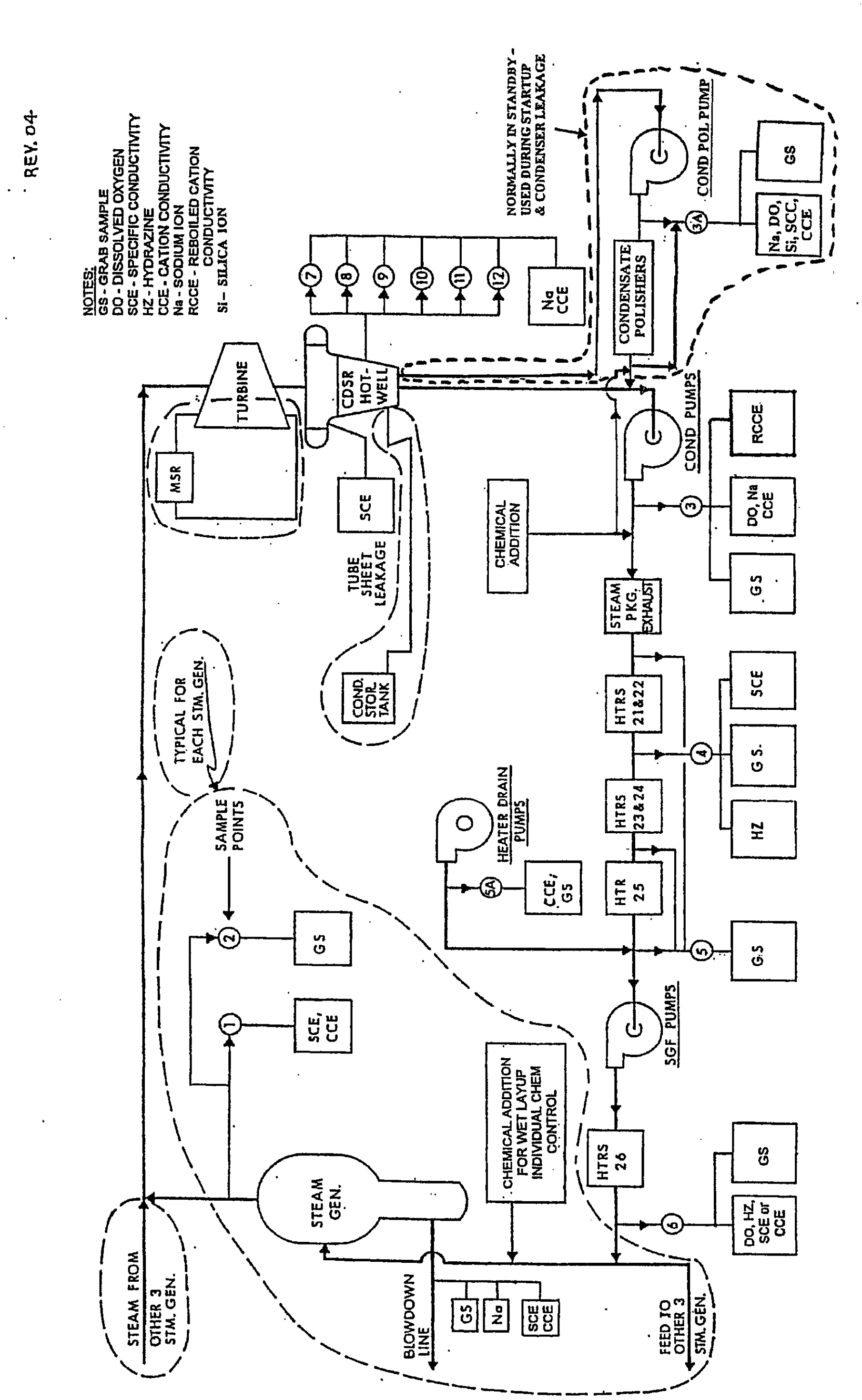
SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Sample System Primary Sample Panel CP-166A	
		Figure 9.3-12

See PID-1-SS-B20521

SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Sample System Steam Generator Sample Panel 166B P&ID	
		Figure 9.3-13

See PID-1-SS-B20520

SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Sample System (Nuclear - Post Accident) Detail	
		Figure 9.3-14



SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Secondary Steam and Water Sampling Subsystem Schematic	
		Figure 9.3-15

See PID-1-WLD-B20216

See PID-1-WLD-B20218

See PID-1-WLD-B20219

SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Waste Processing Liquid Drains Containment Building Sumps	
		Figure 9.3-18

See PID-1-WLD-B20220

See PID-1-WLD-B20221

SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Waste Processing Liquid Drains RHR Equipment Vaults 1 and 2	
		Figure 9.3-20

See PID-1-WLD-B20222

SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Waste Processing Liquid Drains Primary Auxiliary Building	
		Figure 9.3-21 Sh. 1 of 2

See PID-1-WLD-B20223

See PID-1-WLD-B20224

SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Waste Processing Liquid Drains Administration Building and RCA Walkway Details	
		Figure 9.3-22

See PID-1-WLD-B20225

See PID-1-WLD-B20226

See PID-1-WLD-B20227

See PID-1-WLD-B20228

See PID-1-WLD-B20229

SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Waste Processing Liquid Drains Waste Processing Building Sumps	
		Figure 9.3-25

See PID-1-CS-B20720

Chemical and Volume Control System Overview

Figure 9.3-26

See PID-1-CS-B20722

Chemical and Volume Control System Heat Exchangers Detail

Figure 9.3-27

See PID-1-CS-B20723

SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Chemical and Volume Control System Purification Detail	
		Figure 9.3-28

See PID-1-CS-B20726

See PID-1-CS-B20725

SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Chemical and Volume Control Charging System Detail	
		Figure 9.3-30

See PID-1-CS-B20727

SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Chemical and Volume Control System Thermal Regeneration Detail	
		Figure 9.3-31 Sh. 1 of 2

See PID-1-CS-B20728

See PID-1-CS-B20729

See PID-1-CS-B20724

See PID-1-BRS-B20853

See PID-1-BRS-B20856

SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Boron Recovery System Filtration Detail	
		Figure 9.3-35

See PID-1-BRS-B20857

SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Boron Recovery System Storage Detail	
		Figure 9.3-36

See PID-1-BRS-B20858

SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Boron Recovery System Evaporation Detail [3 sheets]	
		Figure 9.3-37 Sh. 1 of 3

See PID-1-BRS-B20859

See PID-1-BRS-B20860

See PID-1-BRS-B20861

SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Boron Recovery System Testing and Demineralization Detail	
		Figure 9.3-38

See PID-1-BRS-B20854

See PID-1-BRS-B20855

See PID-1-VG-B20779

SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Vent Gas System Overview	
		Figure 9.3-40

See PID-1-VG-B20780

See PID-1-VG-B20782

See PID-1-CBA-B20300

See PID-1-CBA-B20304

See PID-1-CBA-B20305

SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Control Building Air Handling Control Room Detail	
		Figure 9.4-3

See PID-1-MAH-B20497

SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Miscellaneous Air Handling Fuel Storage Building Detail	
		Figure 9.4-4

See PID-1-MAH-B20492

SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Miscellaneous Air Handling Key Plan	
		Figure 9.4-5

See PID-1-MAH-B20494

SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Miscellaneous Air Handling PAB El. 53'-0 And 81 '-0 Detail	
		Figure 9.4-6

See PID-1-MAH-B20495

Miscellaneous Air Handling PAB and Containment Enclosure Ventilation Area Detail

Figure 9.4-7

See PID-1-MAH-B20496

SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Miscellaneous Air Handling PAB and RHR Vaults Detail	
		Figure 9.4-8

See PID-1-MAH-B20493

See PID-1-MAH-B20507

See PID-1-MAH-B20508

SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Glycol Flow and Air Flow Diagrams - AC System Electrical Vault and Stairs	
		Figure 9.4-10

See PID-1-MAH-B20498

See PID-1-MAH-B20499

Miscellaneous Air Handling Waste Processing Building Detail

Figure 9.4-11 Sh. 2 of 4

See PID-1-MAH-B20500

See PID-1-MAH-B20501

SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Miscellaneous Air Handling Waste Processing Building Detail	
		Figure 9.4-11 Sh. 4 of 4

See PID-1-MAH-B20502

SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Miscellaneous Air Handling Waste Processing Building Detail of Elev. (-)31'-0"	
		Figure 9.4-12

See PID-1-MAH-B20505

See PID-1-MAH-B20506

See PID-1-MAH-B20504

SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Miscellaneous Air Handling Containment and Purges Detail (COP,CAP)	
		Figure 9.4-14

See PID-1-MAH-B20503

SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Miscellaneous Air Handling Detail	
		Figure 9.4-15

See PID-1-DAH-B20624

SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Diesel Generator Building Air Handling	
		Figure 9.4-16

See PID-1-HW-B20048

See PID-1-HW-B20049

See PID-1-HW-B20053

SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Hot Water Heating Diesel Generator And Control Building Detail	
		Figure 9.4-18

See PID-1-CBA-B20303

SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Control Building Air Handling Detail	
		Figure 9.4-19

See PID-1-CBA-B20302

SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Control Building Air Handling Emergency Switchgear Area Detail	
		Figure 9.4-20

See PID-1-AAH-B20001

See PID-1-CWA-B20240

SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Circulating Water Pumphouse Air Handling	
		Figure 9.4-22

See PID-1-SWA-B20372

See PID-1-TAH-B20170

SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Turbine Building Air Handling Detail	
		Figure 9.4-24 Sh. 1 of 3

See PID-1-TAH-B20171

See PID-1-TAH-B20172

See PID-1-CBA-B20309

SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Control Building, Air Conditioning System, Safety Related, NSS Chilled Water System	
		Figure 9-4-25

See PID-1-FP-B20264

SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Fire Protection Overview	
		Figure 9.5-1

See PID-1-FP-B20271

DELETED

See PID-1-FP-B20274

SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Fire Protection Yard Piping	
		Figure 9.5-4

See PID-1-FP-B20266

See PID-1-FO-B20938

See PID-1-FP-B20269

Fire Protection Turbine Building Detail

See PID-1-FP-B20270

SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Fire Protection Turbine Building Detail	
		Figure 9.5-7 Sh. 2 of 2

See PID-1-FP-B20268

SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Fire Protection Standpipe Detail	
		Figure 9.5-8

See PID-1-DG-B20456

SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Diesel Generator Train A and Train B Overview	
		Figure 9.5-9 Sh. 1 of 2

See PID-1-DG-B20457

See PID-1-DG-B20459

SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Diesel Generator Fuel Oil System Train A and Train B Detail [2 sheets]	
		Figure 9.5-10 Sh. 1 of 2

See PID-1-DG-B20464

SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Diesel Generator Fuel Oil System Train A and Train B Detail [2 sheets]	
		Figure 9.5-10 Sh. 2 of 2

See PID-1-DG-B20461

SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Diesel Generator Cooling Water System Train A and Train B Detail	
		Figure 9.5-11 Sh. 1 of 2

See PID-1-DG-B20466

SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Diesel Generator Cooling Water System Train A and Train B Detail	
		Figure 9.5-11 Sh. 2 of 2

See PID-1-DG-B20460

See PID-1-DG-B20465

See PID-1-DG-B20458

See PID-1-DG-B20463

SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Diesel Generator Lube Oil Train A and Train B Detail	
		Figure 9.5-13 Sh. 2 of 2

See PID-1-DG-B20462

SEABROOK STATION UPDATED FINAL SAFETY ANALYSIS REPORT	Diesel Generator Intake, Exhaust & Crankcase Vacuum System Train A and Train B Detail	
		Figure 9.5-14 Sh. 1 of 2

See PID-1-DG-B20467