9.0 NEW AND SPENT FUEL STORAGE AND HANDLING

The design of the Shearon Harris Nuclear Power Plant as shown on Figures 1.2.2-55 through 1.2.2-59 incorporates the use of three spent fuel pools and one new fuel pool, as well as a cask loading pool. All of these pools are interconnected by the main fuel transfer canal and the fuel transfer canal. The design and operation of the fuel pool meets the requirements of 10 CFR 50.68(b). SHNPP has chosen to comply with 10 CFR 50.68(b).

Should the need exist, the SHNPP is designed such that spent fuel from Carolina Power & Light's Brunswick and Robinson Nuclear Power Plants could be stored in addition to the spent fuel from the SHNPP. The design of the fuel pools and storage racks allow for the storage of new and spent fuel in any applicable fuel pool. New fuel storage is not limited to the pool designated as the new fuel pool. The new and spent fuel pools will also have the capability to accept spent fuel storage racks for CP&L fuel other than the PWR fuel to be used by the SHNPP. A discussion of these racks is presented in Sections 9.1.1 and 9.1.2. The fuel handling devices are discussed in Section 9.1.4.

9.1 FUEL STORAGE AND HANDLING

9.1.1 NEW FUEL STORAGE

9.1.1.1 Design Bases

New fuel storage is provided by wet fuel pools, as well as the new fuel dry storage racks in the new fuel inspection pit. The PWR racks in Pool A and B are designed to store both new and spent fuel. The new fuel dry storage racks within the new fuel inspection pit provide dry storage for new fuel assemblies. The cells of the new fuel dry storage racks are identical to the PWR racks used in Pools A and B. The arrangement of the racks varies from location to location. In both cases (wet and dry storage), restrictions apply to the cells that can be used for new fuel storage. In dry storage racks, only 1-of-4 cells are used. Alternating rows and columns in each rack module are blocked off by a barrier. In one rack module an additional damaged corner cell is also blocked by a barrier. In wet storage a 2-of-4 checkerboard is required. Administrative controls are used instead of barriers for the wet storage.

When storing fuel, these rack modules provide safe storage in either a wet pool or dry environment and are designed for underwater installation and removal. The new fuel inspection pit, which contains the new fuel dry storage racks, is maintained in a dry condition and Pool A and B are maintained in a flooded condition.

The fuel racks consist of individual vertical cells fastened together through top and bottom supporting grid structures to form integral free-standing, self-supporting modules. Boraflex is encapsulated into the stainless steel walls of the storage cells. However, credit is not taken for the Boraflex in the criticality analysis of the PWR racks either in dry or wet storage. The PWR rack modules have a center-to-center spacing of 10.5 inches between cells. Table 9.1.2-1 provides a listing of rack modules used in Pools A and B. Table 9.1.2-2 shows fabrication parameters for individual racks.

The dry storage racks shall maintain the allowable stored fuel assemblies in a sub-critical array such that; (1) The k-effective calculated assuming maximum fuel assembly enrichment and flooded with unborated water is less than 0.95, at a 95 percent probability, 95 percent

confidence level. (2) The k-effective corresponding to optimum moderation (low density or heterogeneously distributed water) is less than 0.98, at a 95 percent probability, 95 percent confidence level.

9.1.1.2 Facilities Description

Pool A and B are located in the south end of the Fuel Handling Building, as shown on Figures 1.2.2-55 through 1.2.2-59. Pools A and B are described in Section 9.1.2.

The new fuel inspection pit, which contains the new fuel dry storage racks, is a concrete structure located in the north end of the Fuel Handling Building at Elevation 261'. It has a concrete floor with no steel liner. It is not usable for wet storage, due to an open stairwell leading down to the 216' elevation, with a non-waterproof door into the pit.

9.1.1.3 Safety Evaluation

The Fuel Handling Building is designed in accordance with Regulatory Guide 1.13, Rev. 1, "Spent Fuel Storage Facility Design Basis," and provides protection to the fuel racks and other pieces of equipment against natural phenomena such as tornadoes, hurricanes, and floods as discussed in Sections 3.3, 3.4, and 3.5.

The design and safety evaluation of the fuel racks is in accordance with the NRC position paper, "Review and Acceptance of Spent Fuel Storage and Handling Applications."

The racks, being ANS Safety Class 3 and Seismic Category I structures, are designed to withstand normal and postulated dead loads, live loads, loads due to thermal effects, and loads caused by the operating bases earthquakes and safe shutdown earthquake events in accordance with Regulatory Guide 1.29, and stress allowables defined by ASME Code, Section III. The racks can withstand an uplift force equal to the maximum uplift capability of the spent fuel bridge crane.

For dry storage, the design of the PWR fuel racks is such that with the inspection pit flooded with unborated water at optimum fully dense moderation, $k_{eff} \leq 0.95$. For interspersed (mist) moderator conditions, $k_{eff} \leq 0.98$. The limiting fuel assembly analyzed is described in FSAR Section 4.3.2.6.

The criticality safety of the storage of new PWR fuel in wet storage in Pools A and B is described in Section 9.1.2.3. The storage of new PWR fuel in Pools C and D is prohibited by administrative control.

Consideration is given to the inherent materials of construction. Fuel handling accidents will not alter the rack geometry to the extent that the criticality acceptance criteria is violated. The criticality safety analysis is discussed in Section 4.3.2.6.

Materials used in construction are compatible with the storage pool environment, and surfaces that come in contact with the fuel assemblies are made of annealed austenitic stainless steel.

9.1.2 SPENT FUEL STORAGE

9.1.2.1 Design Bases

Spent fuel storage is provided by the New Fuel Storage Pool (Pool A) and the three spent fuel pools commonly referred to as Pool B, C, and D. The maximum storage capacity of these three pools is dependent on the type of storage racks and assemblies chosen for installation. The actual number and type of assemblies being stored will vary depending on future storage requirements. The currently licensed storage capacity of each pool is provided in Table 9.1.2-1. The four pools are licensed to include 3404 PWR storage cells and 4628 BWR storage cells, for a total storage capacity of 8032 fuel assemblies.

Pools A and B are located at the south end of the Fuel Handling Building and provide storage for new and spent fuel assemblies using a combination of various rack modules sizes. Pools C and D are located in the north end of the Fuel Handling Building and provide additional storage for spent fuel assemblies using a combination of various rack modules sizes. Storage racks are to be added on an as needed basis. Rack modules are designed for underwater installation and removal, should rack rearrangement be desired. Module arrangement may vary, based on changing fuel storage needs, provided the structural analysis shows the proposed module arrangement to be acceptable. Rearrangement of the racks would have no effect on maximum stored fuel criticality.

To accommodate the storage of spent fuel from other nuclear plants in the CP&L system, Pools A, B, and C are designed for the storage of both PWR and BWR fuel. The 9x9 PWR racks designed for Pool C are dimensionally interchangeable with the 13x13 BWR rack modules designed for Pool C. Table 9.1.2-1 provides a listing of the various rack sizes.

The fuel racks consist of individual vertical cells fastened together through top and bottom supporting grid structures, or intermittent welds along the corners of adjacent fabricated cell boxes, to form an integral of storage cells. The bottom of the storage cell array is connected to a baseplate, which provides additional rigidity and also serves to support the fuel assemblies in storage. The rack modules are free-standing and self-supporting. A neutron absorbing material is encapsulated into the stainless steel walls of the BWR racks in Pools A, B and C and the PWR racks in Pools C and D. The absorbing material originally placed in the PWR racks in Pools A and B is degraded and is no longer credited in criticality analyses.

The PWR rack modules located in Pools A and B have a center-to-center spacing (pitch) of 10.5 inches between cells. The PWR rack modules designed for Pools C and D have a center-to-center spacing (pitch) of 9.0 inches between cells. The BWR rack modules located in Pools A, B and C have a center-to-center spacing (pitch) of 6.25 inches between cells. Table 9.1.2-2 provides other basic dimensional parameters for the SHNPP spent fuel racks.

The BWR storage racks in Pools A, B and C and the PWR storage racks in Pools C and D are designed to maintain a subcritical array of $k_{eff} \leq 0.95$ even in the event that the pools are flooded with unborated water. The PWR racks in Pools A and B can be used to store new or non-Burnup Credit fuel in 2-of-4 spacing or Burnup Credit qualified fuel in 4-of-4 spacing with a $k_{eff} < 1.0$. Soluble boron is credited to maintain $k_{eff} \leq 0.95$. Details of the criticality safety basis are presented in FSAR Section 4.3.2.6 and below. Insertion of a BWR fuel assembly into a rack designed to store PWR fuel will result in a subcritical array of $k_{eff} \leq 0.95$. Conversely, a PWR

fuel assembly will not fit into a BWR spent fuel rack storage cell, thus, mislocation is not a concern.

9.1.2.1.1 BWR Racks

There are two designs for BWR racks for spent BWR fuel storage. Both have the same pitch and both use a neutron absorber (either Boral or Boraflex). The limiting design in Pools A and B is such that with reactivity bounded by the 8 x 8R, 3.2 w/o U235 assembly, the k_{eff} for the racks will not exceed 0.95 with the spent fuel pool flooded with unborated water. With this limit on assembly reactivity, all fuel assemblies located in Brunswick Steam Electric Plant (BSEP or BNP) Unit 1 through reload 5 and all fuel assemblies located in BSEP Unit 2 through reload 6 are conservatively bounded and may be stored at SHNPP. For Pool C, the design permits a BWR assembly with a maximum planar average enrichment less than 4.6 wt % U235 and k_{eff} < 1.32 for the standard cold core geometry (SCCG). No BWR racks are planned for Pool D.

9.1.2.1.2 PWR Racks in Pools A and B

The PWR storage modules located in Pools A and B are designed with a gap between adjacent storage cells. This gap is referred to as a "flux trap". The poison originally included in the design is no longer credited in criticality analysis. The racks can be used for new fuel assemblies using a 2-of-4 storage pattern. A soluble boron concentration of 500 ppm is required to maintain k_{eff} < 0.95 under normal conditions that do not involve fuel movement. Included in the normal conditions are (1) interactions with adjacent BWR storage racks, (2) the insertion of a specified number of Non Fuel Bearing Containers (NFBCs) into empty spaces in the 2-of-4 region, and (3) the interaction with adjacent 4-of-4 storage of spent fuel. The allowed number of NFBCs (e.g. mock fuel assemblies, storage baskets for irradiated hardware, etc.) is one item for every six contiguous storage cells. The 2-of-4 and the 4-of-4 regions must be separated by an interface region if fresh and spent fuel is stored within the same rack. The interface can either be a row of waterholes or a row of spent assemblies (fuel assemblies that meet the Burnup Credit (BUC) curve requirement) in a checkerboard pattern with the fresh assemblies.

The rack module separation is sufficient for a region boundary separation for either BWR-PWR or PWR-PWR. The storage of fuel with the 4-of-4 region credits the use of BUC curve on stored fuel. Irradiated PWR fuel that does not meet the BUC curve will have to be stored in a 2-of-4 region or stored in Pool C.

As described in FSAR Section 4.3.2.6, a burnup credit (BUC) curve is established to designate fuel assemblies that are permitted to be stored in 4-of-4 storage in PWR flux trap racks. As part of preparing fuel shuffle documents, a determination will have to be made as to whether an assembly meets the BUC curve or not. Fuel assemblies that meet the curve are designated as BUC rack qualified assemblies in the discussion that follows. These assemblies will generally be "spent fuel". Fuel that does not meet the BUC curve (non-BUC fuel) will be new or partially burned fuel. Fuel cycle operation may result in spent fuel that does not meet the BUC.

For the PWR racks in Pools A and B, the inadvertent misloading of new, fresh fuel assembly into a required space (water hole) in the 2-of-4 pattern is considered an accident condition. The 2-of-4 pattern in the rack will be readily observable by the personnel performing the fuel handling and operation procedures state the limitation of the 4-of-4 pattern. The analysis assumed that a fresh assembly was placed in the center of four other fresh assemblies or along

the side of a rack. It has been determined that this accident will result in a subcritical array of k_{eff} ≤ 0.95 if credit is taken for soluble boron. Administrative procedures assure the presence of soluble poison during fuel handling operations will preclude the possibility of the simultaneous occurrence of the loss of all soluble boron and a misloaded PWR fuel assembly. Under this accident condition, credit for the presence of soluble boron is permitted by NRC guidelines. It has been determined that a minimum soluble boron concentration of 1000 ppm would be adequate to assure that the limiting k_{eff} ≤ 0.95 is not exceeded. A minimum 500 ppm soluble boron concentration is required for fuel storage with fuel handling activity with burnup credit (BUC) rack qualified spent fuel assemblies. For either condition the concentration is much lower than the 2000 ppm concentration required by administrative controls. Therefore, subcriticality is assured under normal and accident conditions.

The safety analyses of PWR fuel storage and handling in Pools A and B are subject to additional restrictions and controls that are described by procedure. The controls and restrictions include:

- Framatome fuel assemblies cannot be designated as BUC qualified assemblies if they were irradiated with a removable absorber component such as a Wet Annular Burnable Absorber Assembly (WABA) or Burnable Poison Rod Assembly (BPRA). Gadolinia bearing fuel is not restricted.

- The Spent Fuel Pool maximum water temperature shall not exceed 150 degrees F for normal operation, including refueling.

- New fuel assembly designs not bounded by the design basis assembly shall be demonstrated to be less reactive than the design basis assembly at all assembly average burnups in the SFP rack geometry in order to qualify for BUC storage.

- NFBC may be placed in any PWR BUC rack cell.

- NFBC with non-fuel components may be stored in the water holes in the non-BUC region provided they are loaded with a loading pattern no greater than 1 NFBC in any 6 rack cells or as a replacement for a non-BUC assembly. Refer to Figure 9.1.2-1.

- There are no restrictions on placement of fresh (non-BUC) racks adjacent to either the BUC racks or BWR racks.

- The 2-of-4 pattern for non-BUC region and the interface between non-BUC and BUC regions must be separated. The interface region may be either an empty row/column or BUC-qualified fuel in a checkerboard with the non-BUC fuel. This is illustrated in FSAR Figure 9.1.2-2.

- The gap between cells in the PWR storage modules located in Pools A and B allow lead-in openings to be included at the top of the storage cells to guide the fuel during insertion. The BWR racks design for all four pools do not require or contain flux traps, since subcriticality of all fuel is ensured by considering storage of fuel with the highest reactivity. BWR storage locations do not have a lead-in, since the fuel lower nozzle design facilitates insertion into the storage cell.

9.1.2.1.3 PWR Racks in Pools C and D

The PWR storage modules designed for Pools C and D are maximum density "Region 2" style racks, which do not include a flux trap between adjacent cells. These racks ensure subcriticality under normal storage conditions by placing burnup enrichment limitations on stored fuel.

Subcriticality in PWR racks designed for Pools C and D under accident conditions, except for fuel misloading, is also ensured by the design of the storage module without taking credit for soluble boron. The inadvertent misloading of a fresh fuel assembly into a Pool C or D PWR storage cell is highly unlikely, primarily due to the distance from the new fuel handling areas. Nevertheless, this condition has been considered and it has been determined that this accident will result in a subcritical array of $k_{eff} \leq 0.95$, if credit is taken for soluble boron. Administrative procedures to assure the presence of soluble poison during fuel handling operations will preclude the possibility of the simultaneous occurrence of the loss of all soluble boron and a misloaded PWR fuel assembly. The largest reactivity increase would occur if a new fuel assembly of the highest reactivity (i.e., fresh, unburned) were to be positioned within an otherwise fully loaded PWR storage rack module. Under this accident condition, credit for the presence of soluble boron is permitted by NRC guidelines[1], and it has been determined that a minimum soluble boron concentration of about 400 ppm would be adequate to assure that the limiting $k_{eff} \leq 0.95$ is not exceeded. This concentration is much lower than the 2,000 ppm concentration required by administrative controls. Therefore, subcriticality is assured under all accident conditions.

9.1.2.1.4 Spent Fuel Pool Dilution

A spectrum of spent fuel pool dilution accidents was evaluated. The dilution rates varied from 2 gpm to over 200 gpm. The sources of dilution included pipe cracks in moderate energy pipes (fire protection and demineralized water) that are present in the FHB and tube failure in a spent fuel pool heat exchanger. Actuation of alarms (such as fire pump operation, CCW surge tank low level and pool high level) provides warning and opportunity for operator intervention before k_{eff} increases above 0.95. The low end of the dilution rate spectrum is analyzed to cover small long term dilution rates that do not cause spent fuel pool high level alarms. Such rates are postulated for cases where very small dilutions rates result from pool or FPCCS leakage. Pool level is postulated to be maintained with a non-borated source. The routine surveillance on a weekly basis of pool boron concentration provides adequate detection. In summary both large and small dilution events can be detected and mitigated before $k_{eff} > 0.95$.

9.1.2.2 Facilities Description

The spent fuel storage facility is located in the Fuel Handling Building as shown in Figures 1.2.2-55 through 1.2.2-59. The spent fuel is transferred from Containment to the Fuel Handling Building through the fuel transfer tube. The spent fuel bridge crane is used to transfer the spent fuel between the storage racks, fuel pools, transfer canals, and the spent fuel cask. This procedure is carried out with the spent fuel assemblies totally submerged.

There are four fuel pools. The fuel pools at the south end of the FHB are referred to as Pool A or New Fuel Pool Unit 1 and Pool B or Spent Fuel Pool Unit 1. The north end of the FHB

[1] Double contingency principle of ANSI N16.1-1975, as specified in Section 1.2 of the NRC OT Position Paper (Reference 9.1.2-1).

contains two additional fuel pools. The larger of these two pools is referred to as Pool C or Spent Fuel Pool Unit 2. The smaller north end pool is referred to as Pool D, Spent Fuel Pool, or New Fuel Pool Unit 2. These pools are interconnected by means of the main fuel transfer canal which runs the length of the Fuel Handling Building. These pools can be isolated by means of removable gates.

The fuel pools are concrete structures with a stainless steel liner for compatibility with the pool water. Provisions are made to limit and detect leakage from the fuel pools through the use of liner leak detection channels which are placed in various locations outside the stainless steel liner and pool gates. These channels funnel any leakage to drain lines which are checked periodically to determine the structural integrity of the pools and gates. A description of the pool liner is given in Section 9.1.3.

9.1.2.3 Safety Evaluation

The Fuel Handling Building is designed in accordance with Regulatory Guide 1.13, Rev. 1, "Spent Fuel Storage Facility Design Basis," and provides protection to the fuel racks and other pieces of equipment against natural phenomena such as tornadoes, hurricanes, and floods, as discussed in Sections 3.3, 3.4, and 3.5.

The design and safety evaluation of the fuel racks is in accordance with the NRC position paper, "Review and Acceptance of Spent Fuel Storage and Handling Applications," dated April 14, 1978 (Reference 9.1.2-1).

The racks, being ANS Safety Class 3 and Seismic Category I structures, are designed to withstand normal and postulated dead loads, live loads, loads due to thermal effects, loads caused by the operating bases earthquakes, and safe shutdown earthquake events in accordance with Regulatory Guide 1.29, and stress allowables defined by ASME Code, Section III.

Consideration is given to the inherent and fixed neutron absorbing effect of the materials of construction. The design of the racks is such that $k_{eff} \leq 0.95$ under all conditions, including fuel-handling accidents. Due to close spacing of the cells in BWR racks in Pools A, B and C and the PWR racks in Pool C, it is impossible to insert a fuel assembly in other than design locations. A BWR assembly could be placed in a PWR cell, but the uranium mass and assembly design would result in a lower reactivity addition compared to a PWR assembly. Depending on the pool location, sufficient separation between a rack module and a pool wall exists for an assembly to be placed alongside a rack. This accident is analyzed. The PWR racks in Pools A and B may be used for the storage of a new or non-BUC qualified fuel in a 2-of-4 pattern. The 2-of-4 region leaves spaces where it may be possible to inadvertently place a fuel assembly. The inadvertent insertion of a fuel assembly into a 2-of-4 pattern is considered a postulated accident, and as such, realistic initial conditions such as boron in the water can be taken into account to maintain $k_{eff} \leq 0.95$. Also inadvertent insertion of a fuel assembly between the rack periphery and the pool wall is considered a postulated accident and, as such, realistic initial conditions such as boron in the water can be taken into account. This condition has an acceptable $k_{eff} \leq 0.95$. A discussion of the criticality analysis is provided in Section 4.3.2.6.

The racks are also designed with adequate energy absorption capabilities to withstand the impact of a dropped fuel assembly from the maximum lift height of the spent fuel bridge crane. Handling equipment capable of carrying loads heavier than a fuel assembly is prevented by

interlocks or administrative controls, or both, from traveling over the fuel storage area. When such loads must travel over the spent fuel storage area, redundant holding systems as described in Table 9.1.4-1 are used. The racks can withstand an uplift force equal to the maximum uplift capability of the spent fuel bridge crane.

NUREG-0800, Section 9.1.4 Acceptance Criterion 5 requires that, "The maximum potential kinetic energy capable of being developed by any load handled above the stored fuel, if dropped, is not to exceed the kinetic energy of one fuel assembly and its associated handling tool when dropped from the height at which it is normally handled above the spent fuel storage racks."

Analysis performed by Westinghouse showed that the maximum kinetic energy that can be developed by the BPRA tool is 6677 ft. lbs. while that developed by a fuel assembly and its handling tool is only 4961 ft. lbs.

Analysis of potential fuel damage due to this situation was performed by Westinghouse. This analysis showed that although the kinetic energy for the dropped handling tool is 35 percent greater than the kinetic energy for a combined fuel assembly and tool drop accident, that latter case is more limiting from a fuel rod damage potential. In previous accident analyses it was assumed the the dropped fuel assembly fractures a number of fuel rods in the impacted (stationary) assembly and subsequently falls over and ruptures the remaining rods in the dropped assembly. In the case of a dropped tool accident, it is postulated that the handling tool directly impacts a stationary fuel assembly which can cause fuel rods to be fractured in the impacted assembly. However, no additional fuel rods are fractured due to the tool fallover after impact.

The analytical procedure for assessing fuel damage is to conservatively assume that the total kinetic energy of the dropped assembly is converted to fuel clad impact fracture energy. The energy required to break a fuel rod in compression is estimated to be 90 ft. lbs. If the total kinetic energy for the dropped tool, 6677 ft. lbs., is absorbed by fracturing the fuel rod, a total of 74 fuel rods would be broken.

This value is substantially less than the number of fuel rods that could be potentially fractured by a dropped fuel assembly and subsequent fallover. Based on this analysis, it is concluded that the dropped tool accident is not limiting.

Following this analysis, the potential for damage to the fuel racks was analyzed. Five different locations on the top of a standard PWR poison rack assembly were analyzed for straight drop BPRA tool impact.

In addition, the effect of dropping the BPRA tool at an angle such that it ended up lengthwise on the top of the rack was analyzed. However, since the energy is applied to a larger number of cells during the inclined drop, the damage to an individual cell is not as great as that of a straight drop.

The different scenarios analyzed indicate that it may be possible for the cell to drop 1/2-inch to the base or deflect laterally as much as .459 inch. It is possible that the cells located in the drop zone may be damaged enough to obstruct the insertion or removal of fuel. However, in no case does the fuel rack grid structure fail nor is the poison material damaged. Thus, an increase in

reactivity between adjacent cells is not considered likely. This is also supported by the fact that the soluble boron in the pool water counteracts any postulated reactivity increase.

Thus, it has been demonstrated that this situation would have no adverse safety impact on the SHNPP stored fuel.

Tool drop accidents involving the RCCA change tool, BPRA tool, thimble plug tool, PWR spent fuel handling tools, the BWR spent fuel handling tool, refueling trash baskets and items carried by the spent fuel handling tools (vendor supplied refueling trash basket, failed fuel rod storage basket and dummy spent fuel assembly) have been evaluated. If the consequences of dropping a tool from the maximum height which the tool can be raised by the spent fuel bridge crane is not acceptable, then a tool lift limit is indicated on the tool. Tool lift limit marks are placed on tools, and are only applicable when the tools are located in pools A and B. During tool operation, verification that tool lift limits have not been exceeded is determined by observing that the lift limit marks on the tools are not raised above the upper hand rail of the spent fuel bridge crane. If the thimble plug tool, a fuel pool trash basket (including the specimen basket) with its handling tool or the failed fuel rod storage basket with its handling tool is dropped from the full height that can be achieved by the spent fuel bridge crane; or the other tools are dropped from their lift limits, the consequences will be less severe than for a dropped spent fuel assembly and its handling tool. PWR spent fuel racks have been evaluated for a tool drop which develops 6677 ft-lbs of kinetic energy. BWR spent fuel racks have been evaluated for tool drop which develops 3800 ft-lbs of kinetic energy.

Materials used in construction are compatible with the storage pool environment, and surfaces that come into contact with the fuel assemblies are made of annealed austenitic steel. The materials are corrosion resistant and will not contaminate the fuel assemblies or pool environment.

Shielding considerations are discussed in Section 12.3. Radiological conditions associated with the fuel handling accident are discussed in Section 15.7.

9.1.3 FUEL POOL COOLING AND CLEANUP SYSTEM

9.1.3.1 Design Basis

The Fuel Handling Building (FHB) is split into two storage facilities. The storage facility on the south end of the FHB consists of two spent fuel pools, also referred to as Pool A and Pool B. The storage facility on the north end of the FHB consists of spent fuel pools, also referred to as Pool C and Pool D. By design, the pools in the FHB may accommodate both new and spent fuel as described in Section 9.1.1 and 9.1.2. The design bases for the Fuel Pool Cooling and Cleanup System (FPCCS) are as follows:

a) The North and South fuel storage facilities each consist of two 100 percent cooling systems in addition to cleanup equipment for removing the particulate and dissolved fission and corrosion products resulting from the spent fuel.

b) Fuel can be transferred within the operational storage facility as shown on Figure 1.2.2-55. Fuel handling is described in detail in Section 9.1.4.

c) The FPCCS is designed to maintain water quality in the fuel storage pools and remove residual heat from the spent fuel.

d) The current and typical refueling practice at SHNPP of transferring the entire core to the storage facility is referred to herein as the Full Core Offload Shuffle. The refueling practice of transferring only that portion of the core to be discharged to the storage facility is referred to herein as the Incore Shuffle. Both of these practices are reported as Normal Cases when meeting the requirements of the Standard Review Plan. The Abnormal Case is reported as the transfer of the entire core to the storage facility following startup of the next operating cycle. This case is referred to herein as the Post Outage Full Core Offload.

e) The cooling system serving the South fuel storage facility (Pools A and B) has been designed to remove the heat loads generated by the quantities of fuel to be stored in the pools.

   The cooling system serving the North fuel storage facility (Pools C and D) has been designed to remove heat load of no more than 7.0 Mbtu/hr.

f) The Standard Review Plan pool temperature requirement for the Normal Case, assuming a single active failure, is 140°F. The minimum decay time prior to movement of irradiated fuel in the reactor vessel will address both radiological and decay heat considerations. Administrative controls are placed on the minimum cooling time before transfer of spent fuel to the pools, to limit the fuel pool temperature to less than or equal to 150°F. The pool temperature requirement for the Abnormal Case is to be below boiling. The pool concrete design temperature is 150°F, but has been evaluated to 160°F.

g) Calculations of the maximum amount of thermal energy to be removed by the spent fuel cooling system are made using the ORIGEN2 computer code. The ORIGEN2 calculation will reflect a MUR reactor power uncertainty value of 0.34%.

h) The fuel pool heatup rates were calculated using the following assumptions:

   1) No credit for operation of the FPCCS.

   2) No evaporative heat losses.

   3) No heat absorption by concrete or liner.

   4) No heat absorption by spent fuel racks or fuel in pool.

i) The cleanup loop pumps have the capacity to provide makeup water at a rate greater than the loss of water due to normal system leakage and evaporation.

j) Safe water level (and thus sufficient radiation shielding) is maintained in the new and spent fuel pools since the cooling connections are at the tops of the pools.

k) Components and structures of the system are designed to the safety class and seismic requirements indicated in Table 3.2.1-1.

l) The FPCCS will perform its safety related function assuming a single active failure (Reference 9.1.3-1).

9.1.3.2 System Description

The Fuel Pool Cooling and Cleanup Systems are provided as shown on Figures 9.1.3-1, 9.1.3-2, 9.1.3-3 and 9.1.3-4. Each FPCCS is comprised of two fuel pools (Pools A and B - south end, Pools C and D - north end); a Fuel Transfer Canal (south and north); two fuel pool heat exchangers; two fuel pool cooling pumps; two fuel pool strainers; a fuel pool demineralizer; a fuel pool demineralizer filter; and two fuel pool and refueling water purificaiton pumps; a fuel pool skimmer pump; a fuel pool skimmer strainer, and a fuel pool skimmer filter. The common Cask Loading/Unloading Pool and the Main Fuel Transfer Canal are supported by both the south and north FPCCSs. The FPCCS fuel pool skimmer systems have provisions for skimmer connections as follows: three fuel Pool A and D skimmers; five Pool B and C skimmers; south and north transfer canal skimmers; two main transfer canal skimmers, one cask loading/unloading pool skimmer.

The new fuel pool, Pool A, and the spent fuel pool, Pool B, are interconnected by the south Fuel Transfer Canal. The Cask Loading/Unloading Pool, Pool C, and Pool D are interconnected by the north Fuel Transfer Canal. The Main Fuel Transfer Canal connects the south and north Fuel Transfer Canals. Gates are provided to isolate the pools, as needed. Spent fuel is placed in the pools during refueling or from shipments of off-site fuel and stored until it is shipped to a reprocessing facility or otherwise disposed. Fuel handling is discussed in detail in Section 9.1.4. The overall arrangement of the pools is shown on Figure 1.2.2-55. Cooling of spent fuel is accomplished by the fuel pool cooling systems. The location of the inlet and outlet connections to the pools precludes the possibility of coolant flow "short circuiting" the pool.

The Fuel Handling Building is designed to Seismic Category I requirements and to the tornado criteria as stated in Section 3.3.

The fuel pools in the Fuel Handling Building will not be affected by any loss-of-coolant accident in the Containment Building. The water in the pools is isolated from that in the refueling cavity during most of the refueling operation. Only a very small amount of interchange of water will occur as fuel assemblies are transferred during refueling.

The FPCCS is designed for the removal of sensible heat from the fuel pools. For this mode of operation, the equilibrium temperatures are as shown in Table 9.1.3-2.

The FPCCS serving Pools C and D has been designed to remove a decay heat load no greater than 7.0 Mbtu/hr. This limited heat load can be from spent fuel assemblies acquired from HNP, H. B. Robinson Unit 2 and/or Brunswick Units 1 and 2.

The clarity and purity of the fuel pool water is maintained when desired or necessary by passing approximately six percent of the cooling system flow through a cleanup loop consisting of one filter and a demineralizer. The fuel pool cooling pump suction line, which can be used to lower the pool water level, penetrates the fuel pool wall approximately 18 ft. above the fuel assemblies. The penetration location precludes uncovering the fuel assemblies as a result of a postulated suction line rupture.

Piping in contact with fuel pool water is austenitic stainless steel. The piping is welded except where flanged connections are used at the pumps, heat exchangers and control valves to facilitate maintenance.

Control Room and local alarms are provided to alert the operator of high and low pool water level, and high temperature in the fuel pool. A low flow alarm, based on measured flow to the fuel pool, is provided to warn of interruption of cooling flow.

Each Fuel Pool Cooling and Cleanup System (North and South) is comprised of the following components. The component parameters are presented in Table 9.1.3-2.

a) Fuel Pool Heat Exchanger - Two fuel pool heat exchangers are provided. The fuel pool heat exchangers are of the shell and straight tube type. Component cooling water supplied from the Component Cooling Water System (Section 9.2.2) circulates through the shell, while fuel pool water circulates through the tubes. The installation of two heat exchangers assures that the heat removal capacity of the cooling system is only partially lost if one heat exchanger fails or becomes inoperative.

b) Fuel Pool Cooling Pump - Two horizontal centrifugal pumps are installed. The use of two pumps installed in separate lines assures that pumping capacity is only partially lost should one pump become inoperative. This also allows maintenance on one pump while the other is in operation.

c) Fuel Pool Demineralizer - One demineralizer is installed. The demineralizer is sized to pass approximately five percent of the loop circulation flow to provide adequate purification of the fuel pool water and to maintain optical clarity in the pool.

d) Fuel Pool Demineralizer Filter - One fuel pool demineralizer filter. The filter is installed to remove particulate matter from the fuel pool water.

e) Fuel Pool and Refueling Water Purification Filter - The internals, including the filter elements have been removed from fuel pool and refueling water purification filter vessel. The fuel pool and refueling water purification filter vessel can be used to by-pass the fuel pool demineralizer filter.

f) Fuel Pool Cooling and Cleanup System Skimmers - The provisions for the following skimmers are installed: three for fuel Pools A and D, five for Pools B and C, one each for the south and north transfer canals; two for the main transfer canal (one for each FPCCS), one for the cask loading/unloading pool.

g) Fuel Pool and Refueling Water Purification Pumps - Two fuel pool and refueling water purification pumps are provided. Each pump can take suction from and return fluid to the refueling water storage tank via the Containment Spray System, the transfer canal, the fuel pools, or the refueling cavity. Fluids from these systems are purified by the fuel pool demineralizer and filter. Each pump can also take suction from the demineralized water storage tank for make-up to the fuel pools and line flushing.

h) Fuel Pool Cooling and Cleanup System Valves - Manual stop valves are used to isolate equipment and lines and manual throttle valves provide flow control. Valves in contact

with fuel pool water are of austenitic stainless steel or of equivalent corrosion resistant material.

i) Fuel Pool Cooling and Cleanup System Piping - All piping in contact with fuel pool water is of austenitic stainless steel construction. The piping is welded except where flanged connections are used at the pumps, heat exchanger, and control valve to facilitate maintenance.

j) Fuel Pool Gates - The vertical steel gates on the new fuel pool, spent fuel pools, fuel transfer canals, main fuel transfer canal and cask loading pools allow the spent fuel to be immersed at all times while being moved to its destination. They also allow each area to be isolated for drainage, if necessary, and enable new fuel to be stored dry in the new fuel pool.

Fuel Pool water chemistry limits and guidelines are specified in plant chemistry procedures. These procedures insure the fuel pool water chemistry is consistent with current specifications and guidelines established by the NSSS vendor, fuel manufacturer and EPRI standards. The plant Chemistry subunit routinely monitors the fuel pools water by chemical and radiochemical analysis of grab samples. When chemistry exceeds plant procedure limits, appropriate corrective actions are implemented to restore the parameter within its limit. The performance of the Fuel Pool Demineralizer is routinely monitored and when the ion exchange media is depleted, the resin is replaced.

The Spent Fuel Pool fission and corrosion product activities are discussed in FSAR Section 11.1.7. Design and normal operating specific activities are given in FSAR Table 11.1.7-1.

Radiological monitoring of the various samples for the subject system is described in detail in FSAR Sections 11.5.2.5 and 11.5.2.6.

The differential pressure across the flushable filter is measured with on line instrumentation. Before the differential pressure approaches 60 psig, the filter being deposited with maximum amount of crud requires a back-flushing treatment.

9.1.3.3 Safety Evaluation

All fuel pools are cooled by two independent cooling loops, either of which can remove the decay heat loads generated. For Pools C and D, a total decay heat load of no more than 7.0 Mbtu/hr is permitted.

Table 9.1.3-2 provides the fuel pool heat load, equilibrium temperature, and water heat inertia for the Normal Operation, Incore Shuffle, Full Core Offload Shuffle and Post Outage Full Core Offload cases. The combined decay heat load for Spent Fuel Pools A and B is based on an evaluation of equilibrium heat load that will occur subsequent to several cycles of operation with a core power level of 2900 Mwt. The evaluation is based on the assumption that just prior to a refueling outage SFP A/B have all of the spaces filled with previously discharged fuel with the exception of the spaces required for the reload batch and full off load. During the subsequent cycle discharge HNP fuel will be stored in the SFP A/B for several years and older fuel will be moved from SFP A/B to SFP C/D to make space available for the subsequent refueling. The heat load assumed in SFP A/B is based on decay of the discharge batch that would occur during the refueling outage and buildup of decay heat in the reactor core in the subsequent

cycle. The evaluation is based on refueling outage duration of 15 days. For cases assuming a single active failure, a single CCW train supplies both essential and non-essential loads, resulting in reduced CCW flow to the fuel pool cooling system heat exchanger.

Administrative controls are placed on the minimum cooling time prior to transfer of irradiated fuel from the core to the storage facility in order to maintain the pools at less than or equal to 150°F (Reference 9.1.3-2). The minimum cooling time prior to movement of irradiated fuel in the reactor vessel addresses both radiological and decay heat considerations. The most conservative of these two are used in determining the actual required cooling time.

In the event of a single failure in one of these Spent Fuel Cooling Loops, the other loop will provide adequate cooling. The pool temperature with one Fuel Pool Cooling Loop in operation will be equal to or less than 150°F.

The maximum normal heat load which would exist in the A and B fuel pools concurrent with a LOCA would be 18.31 MBTU/hr. The maximum heat load values given in FSAR Table 9.1.3 2 for the Incore Shuffle, Full Core Offload Shuffle and the Post Outage Full Core Offload are not used because a LOCA is not required to be considered concurrent with these conditions.

When the Emergency Core Cooling System is aligned to recirculate from the containment sump to the Reactor Coolant System, the CCW trains are separated from each other and from the non-essential header to maintain protection against single passive failure and to provide sufficient flow to their respective RHR trains. Once separated, each train provides flow to its respective essential header composed of heat loads from the RHR pump and RHR Heat Exchanger.

The containment analysis for SI recirculation assumes that the Non-essential CCW header is isolated from the initiation of SI recirculation to 5 hours after the initiation of the postulated LOCA. Cooling to the spent fuel pools is assumed to be interrupted at the start of the LOCA. Using the heat load listed for normal operations, the limiting spent fuel pool (A/B) is predicted to reach 160°F in 7.2 hours after the accident is initiated. This provides 2.2 hours to complete the manipulations to restore the nonessential CCW header flow from the available CCW pump(s). The heatup rate is conservatively based on the decay heat that is present in the spent fuel pools early in a fuel cycle. The starting temperature of the spent fuel pool is conservatively taken as 125.7°F. This temperature is based on a CCW supply temperature of 105°F and the listed heat load for the Normal Operations case.

All local manual manipulations are performed in areas which are accessible subsequent to a LOCA. Applicable procedures identify the minimum flow rates to be maintained to the RHR heat exchangers and the spent fuel pool heat exchangers. The total time of 7.2 hours is sufficient to prepare and implement the restoration of the cooling to the spent fuel pool heat exchangers.

To assure reliability, each of the fuel pool cooling pumps is powered from separate buses so that each pump receives power from a different source. If a total loss of offsite power should occur, the operator has the option of transferring the pumps to the emergency power source.

In addition, emergency cooling connections are provided in the loops to permit the installation of portable pumps to bypass the fuel pool cooling pumps should they become inoperable when cooling is required in either pool.

As shown on Figure 9.1.3-2, valving and blind flange connections are provided at the suction and discharge side of the fuel pool cooling pumps for emergency connection of a spare cooling pump.

Compliance of the Fuel Pool Cooling and Cleanup System to the guidance of NRC Regulatory Guide No. 1.13, "Fuel Storage Facility Design Basis," is addressed in Section 1.8.

The cooling loop piping and components are designed to Seismic Category I criteria. The cleanup loop is not designed to Seismic Category I criteria; however, suitable valving is provided between the cooling loop and the cleanup loop to permit isolation of the cleanup loop. The cooling loop portion of the FPCCS is protected against externally generated missiles. The fuel pool cooling pumps and associated piping are located in an area of the plant where there are no postulated internally generated missiles. The fuel pool cooling pumps have not been considered credible sources of internally generated missiles. The no-load speed of the pumps is equal to the synchronous speed of the electric motors; consequently, there are no pipe-break plus single failure combinations which could result in a significant increase in pump suction or discharge header. In addition, the FPCCS is protected against the effects of high energy and moderate energy fluid system piping failures (Section 3.6).

The FPCCS is manually controlled and may be shut down safely for reasonable time periods for maintenance or replacement of malfunctioning components.

Whenever a leaking fuel assembly is transferred from the fuel transfer canal to a fuel pool, a small quantity of fission products may enter the fuel pool cooling water. The cleanup loop is provided to remove fission products and other contaminants from the water.

The cleanup loop will normally be run on an intermittent basis as required by fuel pool water conditions. It will be possible to operate the purification system with either the ion exchanger or filter bypassed. Local sample points are provided to permit analysis of ion exchanger and filter efficiencies.

In the event of a high radiation alarm in the Fuel Handling Building, the purification system will be manually started. The cleanup loop is not started automatically since the short delay to manually initiate purification would not significantly speed the reduction of contamination in the pool.

The skimmer system for the new and spent fuel pools consists of surface skimmers, a fuel pool skimmer pump, a fuel pool skimmer pump suction strainer, and a fuel pool skimmer filter. The surface skimmers float on the water surface and are connected via flexible hose to the pump suction piping at various locations on the perimeter of the pools. Flow from the pump is routed through the skimmer filter and returned to the fuel pools below the water level.

Siphoning of the pools is prevented by limiting the skimmer hose length to approximately five (5) feet. In addition the skimmer system return piping enters the pool at a point five (5) feet below the normal pool water level and terminates flush with the pool liner. Therefore, water loss due to failures in the skimmer system piping would be limited to five (5) feet.

A failure of the skimmer system piping would not uncover spent fuel nor interrupt fuel pool cooling since the fuel pool cooling water suction connections are located more than five (5) feet below the normal water level.

Draining or siphoning of the spent and new fuel pools via piping or hose connections to these pools or transfer canals is precluded by the location of the penetrations, limitations on hose length, and termination of piping penetrations flush with the liner. Hoses connected to temporary equipment used in the new and spent fuel pools are administratively controlled to prevent siphoning. The fuel pool cooling water return piping terminate at elevation 279 ft., 6 in. The spent fuel pool suction piping exists at 278 ft., 6 in. and the new fuel pool exits at 277 ft., 6 in.. Normal pool water level is 284 ft., 6 in, with the top of the spent fuel at approximately 260 ft. Skimmer suction piping exits the pools at elevation 285 ft., 3 in.

The reduction of the normal pool water level by approximately 5 ft. due to any postulated pipe failure will have no adverse impact on the capability of the cooling system to maintain the required temperature and it does not affect the required shield water depth for limiting exposures from the spent fuel. The slow heatup rate of the fuel pool would allow sufficient time to take any necessary action to provide adequate cooling using the backup provided while the cooling capability for the fuel pool is being restored.

Technical Specification 3.9.11 requires a minimum amount of water coverage in the fuel pools to reduce the potential doses resulting from a fuel handling accident. This minimum water depth provides sufficient iodine removal capability to maintain both the whole body and thyroid doses well within the acceptable limits of 10 CFR 50.67 which forms the basis for this Technical Specification and the fuel handling accident doses described in Chapter 15. Technical Specification 3.9.11 requires all movement of fuel assemblies and crane operations with loads in the affected pool area be suspended and the water level restored to within its limit within four hours if the water level falls below the minimum required.

The fuel handling accident described in Section 15.7.4 was evaluated with a dropped PWR fuel assembly impacting a stored PWR fuel assembly and ultimately coming to rest in a horizontal position on top of BWR fuel assemblies seated in the BWR fuel storage racks. This scenario results in the minimum water depth above the dropped fuel assembly, which is utilized to determine conservative decontamination factors used for the removal of iodines assumed in the accident evaluation. Assumptions and inputs supporting the fuel handling accident evaluation are located in Section 15.7.4. Maintaining water level in accordance with Technical Specification 3.9.11 assures that water coverages and decontamination factors used in the Chapter 15 fuel handling accident analysis remain bounding.

Alarms are provided for the indication of fuel pool water levels. Alarms for both high and low water levels indicate changing conditions in the pools. The fuel pool low level alarm indicates the minimum required water depth. An additional alarm set at a lower fuel pool water level indicates degraded pool water capacity conditions. The high level alarm provides equipment protection as well as inventory control during pool makeup and water transfer activities.

Normal makeup for evaporative losses and small amounts of system leakage from the fuel pools is accomplished using the Demineralized Water System (DWS), although other sources, such as from the reactor makeup water storage tank or the recycle holdup tank, may also be used. The DWS connects to the fuel pools and refueling water purification pumps, spent fuel pools cooling pumps, and fuel pools skimmer pumps to permit makeup to the fuel pools, or may be directly added to the pools via hoses. The seismic Category I Refueling Water Storage Tank (RWST) may also be aligned to provide borated makeup water to the fuel pools, and a seismic Category I source of emergency makeup water is available from the Emergency Service Water

(ESW) system, by connecting flexible hoses to connections on the ESW and fuel pool cooling and cleanup system piping.

Floor and equipment drain sumps and pumping systems are provided to collect and transfer FPCCS leakage to the Waste Management System. High level alarms are annunciated in the Control Room when high sump level is reached.

Fuel handling equipment is designed such that the equipment cannot fall into the pool under SSE conditions (Section 9.1.4). In addition, the Fuel Handling Building is tornado missile resistant (Section 3.5).

The new fuel pool and spent fuel pools are furnished with stainless steel liners. Although they are classified as non-Nuclear Safety, the fuel pool liners are designed and constructed to the applicable portions of the ASME Code, Section III and they are subject to the Quality Assurance Criteria of 10 CFR 50, Appendix B. Other portions of the fuel transfer system in the Fuel Handling Building which are in communication with the new and spent fuel pools; namely, the fuel transfer canal, the main fuel transfer canal and the fuel cask loading pit, are also furnished with stainless steel liners.

Although these liners are qualified to the same requirements as the fuel pool liners, it is impossible for leakage in these portions of the fuel transfer system to jeopardize the inventory of cooling water in the fuel pools due to a difference in floor elevation. These areas may also be isolated from the fuel pools by gates.

A Permanent Cavity Seal Ring (PCSR) has been installed in the annulus of the reactor cavity adjacent to the refueling cavity. The PCSR is furnished with eight hatch covers which are closed and tested prior to flood-up for refueling. The PCSR is classified as nuclear safety related, subject to the quality assurance provisions of 10 CFR 50 Appendix B. It is designed and constructed to the applicable portions of the ASME Code Section III, Subsection ND, but is not code stamped by an ANI.

Piping and components of the Fuel Pool Cooling and Cleanup System are designed to the applicable codes and standards listed in Section 3.9. Those portions of the FPCCS required to ensure cooling of the fuel pool are Safety Class 3, since their prolonged failure could result in the release to the environment of normally retained gaseous radioactivity. Piping in contact with fuel pool water is austenitic stainless steel.

Fuel pool nozzles shall be stainless steel Seismic Category I designed and fabricated to ASME Section III, Subsection No. ND. However, they are classified as NNS.

9.1.3.4 Inspection and Testing Requirements

Provisions are incorporated in the layout of the system to allow for periodic inspection, using visual and monitoring instrumentation. Equipment is arranged and shielded to permit inspection with limited personnel exposure.

Preoperational and startup tests as described in Section 14.2.12 were conducted in the FPCCS. Periodic tests are required as described in the Technical Specifications. Inservice inspection requirements are described in Section 6.6 and pump and valve testing will be performed as described in Section 3.9.6.

Prior to initial fill, vacuum box testing was performed on the major liner field joints normally exposed to water.

Components of the system were cleaned and inspected prior to installation. Demineralized water was used to flush the entire system. Instruments were calibrated and alarm functions checked for operability and setpoints during testing. The system was operated and tested initially with regard to flow points, flow capacity and mechanical operability.

Data will be taken periodically during normal system operation to confirm heat transfer capabilities, purification efficiency, and differential pressures across components.

9.1.4 FUEL HANDLING SYSTEM

9.1.4.1 Design Bases

The Fuel Handling Building contains one new fuel pool and three spent fuel pools with a transfer canal system that permits transfer of fuel between pools and the reactor cavity in the Containment Building. The Fuel Handling System (FHS) is designed in conformance with Regulatory Guide 1.13 as detailed in Section 1.8.

The Fuel Handling System will provide the following services on SHNPP:

a) provides the means for safely moving the fuel as necessary to accomplish receipt and storage of new and spent fuel, refueling, receiving shipments of offsite spent fuel, and shipment of spent fuel to offsite locations.

b) provides the means for safely preparing the plant facilities for fuel movement, such as placement of fuel transfer canal gates in appropriate positions, dismantling and replacing reactor vessel components to allow for refueling and placement of portable barriers for safe spent fuel cask handling.

c) provides the means for safely transferring spent fuel among all fuel pools.

d) provides shielding for protection of personnel from excessive radiation exposure during refueling, inspection, and fuel storage.

e) provides that either:

    1) a load drop resulting from a single electrical or lifting cable failure is precluded, or;

    2) the consequences of a load drop can be accommodated without affecting the ability to bring the plant to a safe shutdown condition or to control the release of significant amounts of radioactive material.

f) is designed such that maximum design load on the wire rope hoisting cables shall not exceed 1/5 ultimate strength of the cables.

g) provides appropriate containment isolation boundaries for containment penetration.

h) is designed such that lifting devices have appropriate administrative controls, interlocks and stopping capability.

i) is designed such that fuel lifting and handling equipment and structures will not fail in such a manner as to damage Seismic Category I equipment or structures in the event of an SSE.

Structures, systems, and components designed as Seismic Category I are shown in Table 3.2.1-1. Structures, systems, and components which could damage safety-related equipment upon failure are designed to withstand an SSE event without causing such damage. Components that are designed for Safety Class 1, 2, or 3 are shown in Table 3.2.1-1.

9.1.4.1.1 Fuel transfer decay heat

The refueling water provides a reliable and adequate cooling medium for spent fuel transfer. The operable fuel pools are connected to the pool cooling and clean-up systems, which are discussed in detail in Section 9.1.3.

9.1.4.1.2 Fuel transfer radiation shielding

Adequate shielding from radiation is provided during reactor refueling by transferring and storing spent fuel underwater and maintaining a safe shielding depth of water above the fuel assemblies during refueling. This permits visual control of the operation at all times while maintaining acceptable radiation levels for periodic occupancy of the area by operating personnel.

9.1.4.2 System Description

9.1.4.2.1 System

The Fuel Handling System consists of the equipment and associated structures used to handle fuel from the time of receipt until it leaves the plant and the handling equipment used to prepare the reactor to discharge and receive fuel.

The equipment consists of:

a) Containment building overhead polar crane.

b) Manipulator crane.

c) Spent fuel bridge crane.

d) Spent fuel cask handling crane.

e) Auxiliary crane.

f) Fuel handling tools and fixtures.

g) Fuel transfer system.

h) Fuel racks.

i) New fuel elevator.

The following areas are associated with the fuel handling equipment:

a) Refueling cavity.

b) Fuel pools and fuel transfer canal system.

c) New fuel storage area.

d) Spent fuel cask loading pool and decontamination area.

Refer to Figures 1.2.2-55 through 1.2.2-59 for general arrangements of the Fuel Handling Building.

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

a) The refueling cavity which is flooded only during shutdown for refueling.

b) The new and spent fuel pools and fuel transfer canal system.

9.1.4.2.2 Components

9.1.4.2.2.1 Reactor vessel head lifting device

The reactor vessel head lifting device consists of a welded and bolted structural steel frame which enables the overhead polar crane to lift the head and store it during refueling operations. This device is part of the Integrated Reactor Vessel Head (IRVH).

9.1.4.2.2.2 Reactor internals lifting device

The reactor internals lifting device is a structural frame mechanism which provides the means of gripping the upper and lower internal packages to transmit the lifting load to the crane (refer to Figure 9.1.4-1). By the use of auxiliary brackets, the assembly is guided onto the internal packages. Attachment is accomplished by manually connecting the assembly to the internals with handling tools operated from the internals lifting rig platform. The upper internals are stored in the flooded refueling cavity during refueling. Although their removal is not required for refueling, the lower internals may be stored in the flooded refueling cavity when required.

9.1.4.2.2.3 Manipulator crane

The manipulator crane is a rectilinear bridge and trolley crane with a vertical mast extending down into the refueling water (refer to Figure 9.1.4-2). The bridge spans 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 out of the mast to grip the fuel assembly. The gripper tube is long enough so 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.

Controls for the manipulator crane are mounted on a console on the trolley. The bridge and trolley are positioned by a combination of a video position indication system and visual observation.

This system consists of the following: two video cameras, (one mounted on the bridge truck and the other on the trolley), two sets of position plates, (one set mounted near the guide rail for bridge position and the other on the bridge for the trolley position), a CRT monitor and selector switch, (both mounted in the control console). The drives for the bridge, trolley, and hoist are variable speed and include separate slow speed jog switches for each.

The manipulator crane will not collapse nor become disengaged as a consequence of an SSE.

9.1.4.2.2.4 Spent fuel bridge crane

The spent fuel bridge crane, as shown on Figure 9.1.4-3, is a wheel-mounted walkway spanning the width of the Fuel Handling Building, which carries an electric monorail hoist on an overhead structure. The monorail hoist has access to all spent and new fuel pools, as well as interconnecting transfer canals. The fuel assemblies are moved within the fuel pools by means of a long handled tool (refer to Figure 9.1.4-4) suspended from the hoist. The hoist travel and tool length are designed to limit the maximum lift of a fuel assembly to a safe shielding depth. The spent fuel bridge crane will not drop its load nor leave the rails as a consequence of an SSE. The capacity of the crane is 2,500 lbs; the approximate weight of the handling tool and a fuel assembly is 2,000 lbs. The capacity of the spent fuel bridge crane precludes excessive loads from being carried over spent fuel storage area.

The spent fuel bridge crane hoist is equipped with a load monitor preset to prevent hoist operation at a load of 200 lbs above the weight of a fuel assembly with RCCA and handling tool. Changing of the set points to lift heavier loads will be under administrative control.

9.1.4.2.2.5 Fuel Transfer System

The Fuel Transfer System includes an underwater conveyor car running on tracks extending from the refueling cavity through the transfer tube and into the fuel transfer canal and an upending frame at each end of the transfer tube (refer to Figure 9.1.4-5). To remove a fuel assembly from the reactor, the upending frame in the refueling cavity receives a fuel assembly in the vertical position from the manipulator crane. The fuel assembly is then lowered to a horizontal position for passage through the transfer tube and raised to a vertical position by the upending frame in the fuel transfer canal. The hoist on the spent fuel bridge then takes the fuel assembly to a position in the spent fuel racks via the fuel transfer canals.

To seal the reactor Containment during Unit operation, a blind flange is bolted on the end of the transfer tube in the refueling cavity inside containment, and a manually operated valve is locked closed in the fuel transfer canal in the Fuel Handling Building (Section 6.2.4). The transfer tube and the blind flange are designed to Seismic Category I requirements.

9.1.4.2.2.6 Rod cluster control assembly (RCCA) changing fixture

The following description applies when performing incore shuffles. If the complete core is off-loaded to the Fuel Handling Building, this equipment is not utilized. An RCCA changing fixture is mounted on the refueling cavity wall for transferring RCCA's from fuel assemblies removed from control positions and inserting RCCA's into the fuel assemblies to be placed in the control positions (Figure 9.1.4-6). The fixture consists of two main components: a guide tube mounted to the wall for containing and guiding the RCCA and a wheel mounted carriage for holding the fuel assemblies and positioning fuel assemblies under the guide tube. The guide tube contains a pneumatic gripper on a winch which grips the RCCA and lifts it out of the fuel assembly. By repositioning the carriage, another fuel assembly is brought under the guide tube; and the gripper lowers and releases the RCCA. The manipulator crane loads and removes the fuel assemblies into and out of the carriage.

9.1.4.2.2.7 Spent fuel cask handling crane and auxiliary crane

The spent fuel cask handling crane (150-ton) transfers the spent fuel cask between the railroad car and the spent fuel cask loading pool, (refer to Figures 1.2.2-55 through 1.2.2-59). Design of the Fuel Handling Building and the spent fuel cask handling crane prevents the possibility of the cask passing over or falling into any fuel pool. Permanent mechanical stops, which will withstand the impact of the crane at maximum operating speed, are provided to limit the crane movement so that travel of the center of the main hook is limited to 12 in. south of the centerline of the cask loading pool. Additionally, only the micro drives will be functional in the last 5 ft. of crane travel in the southerly direction as controlled by limit switch. In the unlikely event that the crane comes in contact with the mechanical stops while at maximum operating speed, the maximum swing of the bottom of the cask from its normal position in the vertical plane will be 14.5 inches in the southerly direction. When the cask reaches this deflected position, it is still entirely over the cask pool. Therefore, if dropped while in this extended position, the cask will not come in contact with spent fuel in the fuel pools.

The spent fuel cask handling crane is equipped with limit switches which limit main hook vertical travel to ensure the shipping cask could never fall more than 30 feet through air to any load-bearing surface and will not be raised more than 6 in. above the operating floor.

Two independent systems are provided to prevent the centerline of the main hook of the spent fuel cask crane from coming within 10 ft. 6 in. of the west edge and 15 ft. of the north edge of the nearest spent fuel pool. A combination of limit switches and mechanical stops restrict the crane from the spent fuel pool area. Travel of the center line of the main hook on the cask crane is restricted to the shaded area as shown on Figure 9.1.4-7 by a combination of limit switches and mechanical stops. During cask handling, the center line of the main hook is further restricted under administrative control to the path cross hatched on the figure. A removable barrier is provided with its west face in line with the east edge of the cask unloading pool on top of the dividing wall between that pool and the cask head storage area. The function of the removable barrier is to prevent the cask, in the remote chance of being dropped on top of the dividing wall between the cask loading pool and cask head and yoke storage area, from toppling over and falling into a currently inoperable fuel pool. The dropping cask, after landing on the dividing wall, may start to topple over and strike the barrier. The barrier is designed to withstand the striking force, thus preventing the cask from falling into a currently inoperable fuel pool. The removable barrier is 21 feet 6 inches in overall height. It is set in place by being lowered into a 4 feet deep recess in the concrete floor; therefore, the installed height is 17 feet 6

inches measured from the operating floor. The removable barrier is not used as a mechanical stop.

The auxiliary crane will be used for the installation and re-removal of this barrier.

Figures 9.1.4-7 through 9.1.4-12 show the envelope of travel of the main hook of the spent fuel cask handling crane as controlled by design and administrative control of the crane, and within the main hook envelope, the area to which cask travel will be restricted by administrative control.

There is no safety-related equipment within the possible area of main hook (and, therefore, fuel cask) travel, either on the operating floor level or on floors beneath.

Additionally, a review for the consequences on the building structure due to dropping of the cask crane load block has been performed. The floors within the load block travel envelope will withstand a postulated drop of the load block from the maximum height to which it can be raised with the following exceptions:

a) The stairs near column line 73 will fail, but no safety-related components will be affected.

b) The floor at elevation 286.00 ft. north of column line 73Z and the floor at elevation 261.00 ft. in the new fuel containers storage area will sustain damage, however, the effect is considered to be local. Only non-safety related components will be affected by a load drop in this vicinity.

The auxiliary crane (design capacity of 12 tons) operates on the same runway as the spent fuel cask handling crane as shown in Figures 1.2.2-55 through 1.2.2-59. Two independent systems are provided to prevent the two cranes from coming in contact with each other. Design of each system provides that the auxiliary crane can operate in the common operating area only when the cask crane is in its parking position which is at a safe distance away from the end of travel of the auxiliary crane. While the cask crane is operating, the auxiliary crane is limited to operate at a safe distance away from the common area.

A redundant supporting system is provided on the auxiliary crane in regard to hook, reeving, and braking mechanisms. Provisions are made to manually move the crane to a laydown area for emergency manual lowering of the load. A detailed description of the auxiliary crane is given in Table 9.1.4-1.

Both cranes are capable of retaining the maximum load during an SSE although the crane may not be operable after the seismic event. The bridge and trolley are provided with means for preventing them from leaving their runways with or without hook load during operation or under any postulated seismic event. There is no other lifting device that can carry excessive loads over the fuel storage areas.

9.1.4.2.2.8 Containment Circular Bridge Crane

The overhead crane in the Containment (250 ton/50 ton) used for reactor servicing operations is of the polar configuration, and is seated on a girder bracketed off the containment wall. The crane is capable of retaining a 177.5 ton lifted load (weight of integrated reactor vessel head with lifting rig, which is the weight used by Westinghouse in the head drop analysis and is the

heaviest component to be lifted during refueling operations) during an OBE or SSE, although the crane may not be operable after the seismic event. The bridge and trolley are prevented from leaving their runways with or without the 177.5 ton lifted load during operation or under any seismic event.

The centerline of the crane is offset from the reactor vessel centerline to assure the alignment of lifting devices with all possible loads and to provide clearance for containment spray header piping risers which run vertically along the containment liner.

The consequences of dropping the Integrated Reactor Vessel Head (IRVH) during preparation for or after completion of fuel handling have been analyzed. A summary of the assumption and results of the analysis follows:

The worst case drop scenario is evaluated; normally this is the concentric drop of the IRVH onto the vessel. It is pointed out that the fuel in the RPV will not suffer significant impact damage affecting the integrity of the fuel rods in this event. Also, it is determined that the RPV and primary shield wall (PSW) supporting the RPV (see Section 3.8.3.4.1) would remain intact, the reactor vessel primary nozzles would not be stressed above allowable limits and the reactor coolant loop piping and the essential auxiliary piping connected thereto remain capable of continued circulation of borated water at the specified flow rate. Therefore, the offsite doses would not approach 1/4 of the 10 CFR 100 limits in the concentric drop scenario and would be characteristically less for a non-concentric drop since the refueling cavity concrete floor would absorb part of the load.

During preparation for, and after completion of fuel handling, the IRVH will be transported to and from the laydown area in accordance with the pre-determined load path. The lifting of the IRVH to and from the laydown area is limited by administrative controls to a maximum of 12 in. above the operating floor. (In the laydown area the IRVH is raised above 12 in. to be placed upon its stand.) A drop from this strictly limited height onto the massive concrete and steel structure is not likely to have any serious consequences. Nevertheless, additional protection for required safe shutdown equipment is afforded by redundancy since the dropped IRVH could only damage the limited amount of equipment which is directly below it.

In all of the IRVH drops scenarios considered, the integrity of the vessel was never jeopardized nor was adequate make up water and cooling capacity interrupted such that the fuel could be uncovered. Furthermore, rapid containment isolation is provided with prompt automatic actuation on high radiation so that any unexpected releases result in doses well below 1/4 of the 10 CFR 100 limits taking into account delay times in detection and actuation.

9.1.4.2.2.9 Spent fuel basket and crud collection vessel storage

The north fuel transfer canal (former Unit No. 2 and No. 3 fuel transfer canal) is utilized as a permanent storage area for spent fuel shipping baskets. The baskets are inserted into the IF 300 cask for shipping spent fuel assemblies. Maximum number of baskets to be stored in the canal is 3 PWR and 4 BWR. The baskets will be stored under water and may be positioned anywhere within the canal except during movement of fuel assemblies anywhere within through the canal. At which time the baskets will be stored east of 4'-6" east of column Line M. Storage of the basket within the canal will be freestanding. If the baskets topple over during a seismic event, no damage to the structure or liner will result. The fuel baskets may be damaged as a result of toppling over. However, when stored in the transfer canal, the baskets do not perform

any safety-related function. The auxiliary crane will be utilized to transfer the baskets between the cask loading pool and fuel transfer canal and anywhere within the canal. The north fuel transfer canal is also utilized as a storage location for stainless steel vessels used for collection and retention of spent fuel pool crud (see Section 11.1.7 for discussion of crud). These small (2' diameter, 60" high) steel tanks may also be stored in the "D" Spent Fuel Pool in the interim period prior to that pool being racked for storage of spent fuel, but any crud storage vessels there must be removed prior to racking. A total of no more than 10 of these vessels will be stored in these areas.

9.1.4.2.3 Fuel Handling Description (New and Spent)

New fuel assemblies received for refueling may, if found acceptable by inspection, be stored either dry in racks in the new fuel inspection area or in racks in any operational fuel pool.

Should the need exist in the future, spent fuel from other nuclear plants in the CP&L system would be brought to the SHNPP site in an approved shipping cask. The cask would be placed in the flooded shipping cask pool. The spent fuel would then be removed from the cask and transported to the storage racks. This procedure would be carried out with the spent fuel assemblies totally submerged.

The fuel handling equipment handles the spent fuel assemblies underwater from the time they leave the reactor vessel until they are placed in a container for shipment from the site. 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 are generally divided into two areas: the refueling cavity which is flooded only during a plant shutdown for refueling, and the fuel pools and fuel transfer canals. The refueling cavity and the Fuel Handling Building are connected by a fuel transfer tube which is fitted with a blind flange on the Containment end and a gate valve on the Fuel Handling Building end. The blind flange is in place except during refueling to ensure containment integrity. Fuel is carried through the tube on an underwater transfer car.

Fuel is moved between the reactor vessel and the refueling cavity by the manipulator crane. A rod cluster control changing fixture is located in the refueling cavity for transferring control elements from one fuel assembly to another. The fuel transfer system is used to move fuel assemblies between the Containment Building and the Fuel Handling Building. After a fuel assembly is placed in the fuel upender, the lifting arm pivots the fuel assembly 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 assembly to a vertical position so that the assembly can be lifted out of the fuel upender.

In the Fuel Handling Building, fuel assemblies are moved about by the spent fuel bridge crane or (new fuel only) the auxiliary crane. When lifting irradiated fuel assemblies, the spent fuel bridge crane uses a long-handled tool to ensure that sufficient radiation shielding is maintained. Initially, a short tool is used to handle new fuel assemblies, (see Figure 9.1.4-13) but the new fuel elevator is used to lower the assembly to a depth at which the bridge crane, using the long-handled tool, can place the new fuel assemblies into the storage racks.

Administrative procedures will ensure that no irradiated fuel (outside of sealed casks) will be handled or transported inside the FHB unless the operating floor equipment hatch to the unloading area is in place.

Decay heat, generated by the spent fuel assemblies in the fuel pools, is removed by the Spent Fuel Pool Cooling and Cleanup System, which is described in Section 9.1.3.

After a sufficient decay period, the spent fuel assemblies may be removed from the fuel racks and loaded into the spent fuel shipping cask for removal from the site.

9.1.4.2.4 New Fuel Receiving and Inspecting Procedure

a) New fuel arrives at the north end of the Fuel Handling Building on truck or rail car.

b) The airtight door is opened to admit the carrier and closed behind it.

c) The equipment hatch cover is removed.

d) The new fuel containers are lifted from the carrier by the auxiliary crane or the cask crane and placed on the operating level or in the new fuel inspection area. If the outside airtight door is to be open at any time, the equipment hatch cover will be replaced first.

e) The new fuel container lids are detached by removal of the ball-lock pins and removed by the auxiliary crane and stored. This may be performed on the operating level or in the new fuel inspection area.

f) The fuel assemblies are prepared for upending.

g) The fuel assemblies are upended using the auxiliary crane and lifted with the spent fuel bridge crane or auxiliary crane to the operating level and inspected.

h) After inspection, acceptable new fuel assemblies are transported to any fuel pool, or stored dry in rack(s) in the new fuel inspection area.

i) Unacceptable new fuel may be temporarily stored dry in a rack/racks in the new fuel inspection area or returned to the shipping containers and stored in the new fuel inspection area until corrective action is taken.

j) The new fuel container lids are returned to the containers by the auxiliary crane and attached by insertion of the ball-lock pins.

k) The equipment hatch cover is removed.

l) The empty new fuel containers are lifted by the auxiliary crane and loaded back on the carrier. The equipment hatch cover is replaced.

m) The airtight door is opened and the carrier, loaded with empty new fuel containers, leaves the building and the airtight door is closed.

9.1.4.2.5 Offsite Spent Fuel Receiving Procedure

a) Offsite spent fuel arrives at the north end of the Fuel Handling Building in approved shipping containers by truck or railcar.

b) The airtight door is opened to admit the vehicle and closed behind it.

c) The equipment hatch cover is removed.

d) The cask is prepared for lifting.

e) The cask is lifted by spent fuel cask handling crane and transported to the decontamination or work area. The equipment hatch cover is replaced.

f) Cask is prepared for pool entry.

g) Cask loading pool is flooded and the gate removed.

h) Removable barrier is put in place by the FHB auxiliary crane, or verified to be in place. The removable barrier is designed to withstand DBE seismic loads in accordance with Positions C.2 and C.4, Regulatory Guide 1.29.

i) Cask is transported and lowered into the cask loading pool.

j) Cask head is removed and stored in an appropriate location.

k) Move all fuel baskets that are being stored in the north fuel transfer canal to a position 4'-6" east of column line 'M'.

l) Fuel is removed from the cask using the appropriate long-handled spent fuel tool (PWR or BWR).

m) The spent fuel is transported, using the spent fuel bridge crane, to its pre assigned storage location.

n) After the cask is emptied the head is returned to the cask and replaced.

o) Cask is lifted by the spent fuel cask handling crane and placed in the decontamination area.

p) Removable barrier is placed in storage, or left in place.

q) Cask is prepared for shipment and decontaminated to acceptable levels.

r) The equipment hatch cover is removed.

s) Cask is lifted from the decontamination area and returned to the truck or railcar for removal and the equipment hatch cover is replaced.

t) The airtight door is opened and the vehicle, loaded with the empty cask, leaves the building and the airtight door is closed.

9.1.4.2.6 Spent fuel shipping procedure

a) A truck or railcar arrives at the north end of the Fuel Handling Building carrying an empty approved spent fuel shipping container.

b) The airtight door is opened to admit the vehicle and closed behind it.

c) The equipment hatch cover is removed.

d) The cask is prepared for lifting.

e) The cask is lifted by spent fuel cask handling crane and transported to the decontamination or work area. The equipment hatch cover is replaced.

f) Cask is prepared for pool entry.

g) Cask loading pool is flooded and the gate removed.

h) Removable barrier is put in place by the FHB auxiliary crane, or verified to be in place.

i) Cask is transported and lowered into the cask loading pool.

j) Cask head is removed and stored in an appropriate location.

k) Move all fuel baskets that are being stored in the north fuel transfer canal to a position 4'-6" east of column Line 'M'.

l) Spent fuel is loaded into the cask using the appropriate long handled spent fuel tool (PWR or BWR) and the spent fuel bridge crane.

m) After cask is loaded, the head is returned to the cask and replaced.

n) Cask is lifted by the spent fuel cask handling crane and placed in the decontamination area.

o) Removable barrier is placed in storage, or left in place.

p) Cask is prepared for shipment and decontaminated.

q) The equipment hatch cover is removed.

r) Cask is lifted from the decontamination area and returned to the truck or railcar for removal and the equipment hatch cover is replaced.

s) The airtight door is opened and the vehicle, loaded with the full cask, leaves the building and the airtight door is closed.

9.1.4.2.7 Refueling procedure

9.1.4.2.7.1 Preparation

a) The reactor is shut down and cooled to ambient conditions with a final $k_{eff} \leq 0.95$.

b) A radiation survey is made and if the levels are sufficiently low, the containment is entered.

c) The reactor vessel coolant level is lowered slightly below the reactor vessel flange.

d) IRVH cables are disconnected and removed to storage.

e) Reactor vessel head insulation and instrument leads are removed.

f) The fuel transfer tube blind flange is removed and the refueling cavity drain valves are closed.

g) Checkout of the fuel transfer system and manipulator crane is started.

h) The reactor vessel head nuts are loosened with the hydraulic tensioner.

i) The reactor vessel head studs and nuts are removed to storage. (Stuck studs are a possible exception.) (See Section 1.8)

j) Guide studs are installed in at least two and typically three reactor vessel flange holes, and the remainder of the holes are plugged.

k) The refueling cavity underwater lights are installed.

l) The reactor vessel permanent cavity seal ring hatch covers are closed and tested.

m) Final preparation of tools is made. Checkout of the fuel transfer system is completed. Manipulator crane is parked.

n) The reactor vessel head is unseated, raised approximately one inch, and checked for levelness.

o) The reactor vessel integrated head is lifted slowly clear of the refueling pool cavity.

p) The refueling cavity is filled.

q) The control rod drive shafts are unlatched from the spider.

r) The reactor vessel internals lifting rig is lowered into position and latched to the upper internals package.

s) The reactor vessel upper internals package and drive shafts are lifted out of the vessel and placed in the underwater storage rack.

t) Checkout of manipulator crane is complete (Core Index).

u) The core is now ready for refueling.

9.1.4.2.7.2 Refueling reassembly

The refueling sequence is now started with the manipulator crane. Refueling may be accomplished either by the transfer of the entire core to the storage facility, referred to herein as the Full Core Offload Shuffle or the transfer of only that portion of the core to be discharged to the storage facility, referred to herein as the Incore Shuffle. For the Full Core Offload, some partially spent fuel assemblies and the new fuel assemblies are added to the core. For the Incore Shuffle, some partially spent fuel assemblies have their positions changed and new assemblies are added to the core.

For fuel assemblies containing rod cluster control assemblies (RCCA), the refueling sequence is modified as required. For the Incore Shuffle, if a transfer of the RCCA between fuel assemblies is necessary, the assemblies are taken to the RCCA changing fixture for the exchange. For the Full Core Offload Shuffle, if a transfer of the RCCA between fuel assemblies is necessary, the assemblies are placed in storage racks in the fuel pools and the RCCA is exchanged using the portable RCCA change fixture attached to the spent fuel bridge crane. Such an exchange may be required whenever a spent fuel assembly containing an RCCA is removed from the core and whenever a fuel assembly is placed in or taken out of a control position during refueling rearrangement.

9.1.4.2.7.3 Reactor reassembly

a) The fuel transfer conveyor car is parked, and the refueling cavity is isolated from the fuel transfer canal by closing the manual gate valve on the FHB side.

b) The manipulator crane is parked.

c) The reactor vessel upper internals package is placed in the vessel. The reactor vessel internals lifting rig is unlatched and removed to storage.

d) The full-length control rod drive shafts are relatched to the RCCA spiders.

e) The old seal rings are removed from the reactor vessel head, the grooves cleaned, and new rings installed.

f) The water level in the refueling cavity is lowered just below the flange.

g) The flange surface is cleaned.

h) The reactor cavity is drained.

i) The reactor vessel head is positioned and seated onto the vessel flange.

j) The guide studs are removed to their storage rack. The stud hole plugs are removed.

k) The head studs are placed and retorquing is begun.

l) The refueling cavity drain holes are opened, and the flange for the fuel transfer tube is replaced.

m) Electrical leads are reconnected to the IRVH.

n) Vessel head insulation and instrumentation leads are replaced.

o) The permanent cavity seal ring hatch covers are opened.

p) A system leakage test is performed on the reactor vessel after each refueling outage as required by the ASME Section XI Code Articles IWA-5000 and IWB-5000.

q) Control rod drives are checked.

r) Pre-start-up tests are performed.

9.1.4.2.8 Codes and standards

a) Cranes - Crane Manufacturers Association of America (CMAA) Specification No. 70 and/or AISC Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings.

b) Structures - ASME Code, Section III, Appendix XVII.

c) Electrical - Applicable standards and requirements of the National Electric Code, NFPA 70, and NEMA Standards MAI and ICS for design installation and manufacturing.

d) Materials - Main load-bearing materials to conform to the specifications of the ASTM, ASME, or AISC Standards.

e) Safety -

    i. OSHA Standards, 29 CFR 1910 and 29 CFR 1926, including load-testing requirements.

    ii. ANSI N18.2

    iii. Regulatory Guide 1.29 and GDC 61 and 62.

    iv. ANSI B30.2, "Safety Standards for Overhead and Gantry Cranes."

f) Fuel Transfer Tube: ASME Section III, Code Class 2.

9.1.4.3 Safety Evaluation

The extent of compliance of the fuel handling system with Regulatory Guide 1.13 is discussed in Section 1.8.

Movement of heavy loads over safety related equipment is controlled in accordance with plant procedure MMM-020 "Operation, Testing, Maintenance and Inspection of Cranes and Special

Lifting Equipment." This procedure was reviewed as part of the requested actions for NRC Bulletin 96-02 "Movement of Heavy Loads Over Spent Fuel, Over Fuel in the Reactor Core, or Over Safety Related Equipment" (Reference 9.1.4-1) to confirm that the program continues to be implemented within the licensing basis.

9.1.4.3.1 Fuel handling equipment

Electrical interlocks and limit switches on the bridge and trolley drives of the manipulator crane protect the equipment. In an emergency, the bridge, trolley, and winch can be operated manually using a hand-wheel on the motor shaft. Manual operation of the bridge and trolley, with appropriate administrative controls in place, is also acceptable when used to move fuel to and from open water to avoid fuel assembly interaction and possible damage. (See Westinghouse Specification F-5, "Instructions, Precautions, and Limitations for Handling New and Partially Spent Fuel Assemblies.")

The manipulator crane design includes the following provisions to ensure safe handling of fuel assemblies.

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.

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

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

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

d) 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.

e) 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.

a) When the gripper is engaged, the machine shall not traverse unless the guide tube is either in its full up position or jog permissive have been selected. Then the machine is allowed to traverse in a controlled manner when used to avoid fuel assembly interaction and possible damage as described above.

b) When the gripper is disengaged, the machine shall not traverse unless the gripper is withdrawn into the mast.

c) Vertical motion of the guide tube shall be permitted only in a controlled area over the reactor (avoiding the vessel guide studs), a fuel transfer system, or rod cluster control changing fixture.

d) Traverse of the trolley and bridge shall be limited to the areas of item c and a clear path connecting those areas.

e) A key-operated interlock bypass switch shall be provided to defeat interlocks a through d to allow operation of an inspection camera on the gripper.

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

g) The loaded fuel gripper shall not release unless it is in its down position in the core, or in the fuel transfer system or rod cluster control changing fixture, and the weight of the fuel is off the mast.

h) Raising of the guide tube shall not be permitted if the gripper is disengaged and the load monitor indicates that it is still attached to the fuel assembly.

i) Raising of the guide tube shall not be permitted if the hoist loading exceeds the allowable limit.

j) Lowering of the guide tube shall not be permitted if slack cable exists in the hoist.

k) The guide tube shall be prevented from rising to a height where there is less than the safe shielding depth of water over the fuel assemblies.

l) The guide tube shall travel only at a controlled speed of about 2 fpm when: 1) the bottom of the fuel begins to enter the core, and 2) the gripper approaches the top of the core. In addition, just above those points, the guide tube shall automatically stop lowering, and shall require acknowledgement from the operator before proceeding.

m) The fuel transfer system upender shall be prevented from moving unless the engaged gripper is in the full up position or the disengaged gripper is withdrawn into the mast, or unless the manipulator crane is out of the fuel transfer zone. An interlock shall be provided from the refueling machine to the fuel transfer system to accomplish this.

Suitable restraints are provided between the bridge and trolley structures and their respective rails to prevent derailing due to the SSE. The manipulator crane prevents disengagement of a fuel assembly from the gripper during an SSE.

The following safety features are provided for in the fuel transfer system:

1) Transfer car permissive switch - The transfer car controls are located in the Fuel Handling Building; and conditions in the Containment are, therefore, not visible to the operator. The transfer car permissive switch allows a second operator in the Containment to exercise some control over car movement if conditions visible to him warrant such control.

   Transfer car operation is possible only when both lifting arms are in the down position as indicated by the limit switches. The permissive switch is a backup for the transfer car lifting arm interlock. Assuming the fuel container is in the upright position in the Containment and the lifting arm interlock circuit fails in the permissive condition, the operator in the Fuel Handling Building still cannot operate the car because of the permissive switch interlock. The interlock, therefore, can withstand a single failure.

2) 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 position 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.

3) Deleted by Amendment No. 46.

4) 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 upender is in the vertical position. This interlock is redundant and can withstand a single failure. The basic interlock is a position limit switch in the control circuit. The backup interlock is a mechanical latch device that is opened by the weight of the fuel upender when in the horizontal position.

5) Lifting arm (refueling machine) - The refueling cavity lifting arm is interlocked with the manipulator crane. Whenever the transfer car is located in the refueling cavity, the lifting arm cannot be operated unless the engaged gripper is in the full up position or the disengaged gripper is withdrawn into the mast, or the manipulator crane is over the core.

6) Lifting arm (fuel handling machine) - The lifting arm is interlocked with the spent fuel bridge crane. The lifting arm cannot be lowered unless the spent fuel bridge crane is not over the lifting arm area.

9.1.4.3.2 Overhead cranes

Overhead cranes used in refueling and fuel handling operations include the 250/50 ton overhead polar crane, the 150-ton spent fuel cask handling crane, and the 12-ton (design load)

auxiliary crane. These cranes are classified as non-nuclear safety (NNS) since they neither provide nor support any safety system function.

a) Overhead Polar Crane

The crane is used for removal of the Integrated Reactor Vessel Head and the upper internals package during the refueling shutdown. This crane is provided with seismic restraints to prevent derailment in the event of an SSE or OBE.

A discussion of consequences from dropping the Integrated Reactor Vessel Head is noted in Section 9.1.4.2.2.8. The consequences of various postulated accidents involving the dropping of the reactor vessel upper internals are discussed in Appendix 9.1A, Heavy Loads Analysis.

b) Spent Fuel Cask Handling Crane

This 150-ton crane is provided for handling the spent fuel shipping cask. Crane design and building arrangement preclude travel of this crane hook over the fuel pools. This crane will maintain its structural integrity and hold its load under the dynamic loading conditions of the SSE as described in Section 9.1.4.2.2.7. A postulated drop of the fuel cask will not cause damage to spent fuel and safety-related equipment.

The consequences of load dropping are noted in Section 9.1.4.2.2.7.

c) Auxiliary Crane

The auxiliary crane is used for handling of the removable barrier, pool gates, fuel racks and other miscellaneous items weighing less than 10 tons.

The handling of loads weighing more than 10 tons, but less than 12 tons, is administratively controlled.

The auxiliary crane, a single failure proof crane, is fed from a 3-pole circuit breaker located in a motor control center. With this type of scheme, loss of one phase on the power cable to the cranes is not feasible due to the nature of the circuit protective devices. If an overload or short circuit exists on the feed to the cranes, the circuit breaker would open all three phases.

Reversal of two phases is not a credible event at the power source since the power cables are connected directly to a circuit breaker. The SHNPP power system design precludes loss of a single phase or reversal of any two phases on the power feeds to the plant crane systems.

Kranco, the manufacturer of the auxiliary crane, stated that in the event of a phase loss before drive operations the crane drives cannot operate. In the event of a phase loss while the hoist is operating, the overspeed switch will disconnect the drive automatically at 140 percent of drive rated speed to set the holding brake and stop the load.

In the unlikely event of a phase reversal, a time-delay reverse phase relay actuates such that the crane drives cannot operate. In the event of a phase reversal during hoist motor

operation, the time-delay reverse phase relay will operate to shut down the hoist drive, set the holding brake, and stop the load.

The crane is designed to maintain its structural integrity and hold its load under the dynamic loading conditions of the SSE. Load drop is precluded due to its redundant supporting system as described in Section 9.1.4.2.2.7 and Table 9.1.4 1.

9.1.4.4 Inspection and Testing Requirements

As part of normal plant operations, fuel-handling equipment to be used during the refueling outage is inspected prior to the refueling operations. During the operational testing, procedures are followed to affirm the correct performance of the fuel handling system interlocks.

The test and inspection requirement for the equipment in the fuel handling system are:

1. Manipulator crane, spent fuel bridge crane, rod cluster control changing fixture (if used), and new fuel elevator.

   The minimum acceptable initial test shall include the following:

   a. Manipulator Crane and Spent Fuel Bridge Crane shall be load tested at 125 percent of the rated load.

   b. The equipment shall be checked for proper functional and running operation.

      The following maintenance and checkout tests are recommended to be performed prior to using the equipment:

      a. Visually inspect for loose or foreign parts. Keep free of dirt and grease.

      b. Lubricate exposed gears with proper lubricant.

      c. Inspect hoist cables for worn or broken strands.

      d. Perform operational checks of limit switches and limit switch actuators for proper functional operation.

      e. Check the equipment for proper functional and running operation.

2. Reactor vessel head lifting device and reactor internals lifting device.

   The minimum acceptable test shall include the following:

   a. The devices shall be load tested to 125 percent of the rated load.

   b. The devices shall be assembled to ensure proper component fit up.

      The following maintenance and checkout tests are recommended to be performed prior to using the tools:

a. Visually inspect for loose or foreign parts or damaged surfaces.

b. Visually inspect all engagement surfaces and lubricate with proper lubricant.

c. On the reactor internals lifting device, check for the proper functioning of the engagement and protective rig operators.

3. New fuel assembly handling tool and spent fuel assembly handling tool

The minimum acceptable test shall include the following:

a. The tools shall be load tested to 125 percent of the rated load.

b. The tools shall be checked for proper functional operation.

The following maintenance and checkout tests are recommended to be performed prior to using the tools.

a. Visually inspect the tools for dirt, loose hardware, and for any signs of damage such as nicks and burns.

b. Check the tools for proper functional operation.

4. Fuel transfer system

The minimum acceptable test shall include the following:

a. The system shall be checked for proper functional and running operation.

The following maintenance and checkout tests are recommended to be performed prior to using the tools.

c. Visually inspect for loose or foreign parts. Keep free of dirt and grease.

d. Lubricate exposed gears with proper lubricant.

e. Perform operational checks of limit switches and limit switch actuators for proper functional operation.

f. Check the system for proper functional and running operation.

5. Reactor vessel stud tensioner

The minimum acceptable test shall include the following:

a. The tensioner shall be checked for proper functional and running operation.

The following maintenance and checkout tests are recommended to be performed prior to using the equipment.

a. Visually inspect for loose or foreign parts.

b. Inspect hydraulic lines for wear or damage.

c. Check the hydraulic unit for proper pressurization and if any leaks occur at operating pressure.

9.1.4.5 Instrumentation Requirements

Instrumentation requirements of equipment, including interlocks, are discussed in Sections 9.1.4.2 and 9.1.4.3.

9.1.5 CONTROL OF HEAVY LOADS

9.1.5.1 Introduction / Licensing Background

In 1978 the NRC had concerns with the increased frequency in the handling of spent fuel casks over the spent fuel pools and near spent fuel. These concerns prompted Generic Technical Activity A-36. The purpose of this task was to recommend necessary changes to assure the safe handling of heavy loads. The overall results of Generic Technical Activity A-36 were reported in NUREG-0612, "Control of Heavy Loads at Nuclear Power Plants" dated July, 1980.

In December 1980 the NRC issued Generic Letter 80-113, "Control of Heavy Loads." Generic Letter 80-113 was supplemented in February, 1981 by Generic Letter 81-07, "Control of Heavy Loads," which requested that each utility evaluate their plants against the guidance of NUREG-0612 and provide to the NRC information related to heavy loads at their facility. The submittal was requested in two parts; a six month response - Phase I, and a nine month response - Phase II. Phase I responses were to address Section 5.1.1 of NUREG-0612 and Phase II responses were to address Sections 5.1.2 through 5.1.6 of NUREG-0612.

Shearon Harris Nuclear Power Plant (SHNPP) responded to Phase I of Generic Letter 81-07 and related requests for additional information. At that time, it was noted that SHNPP was currently in the construction phase and thus, a complete response to all items was not possible due to the limited information available. Part I of the SHNPP response on the Control of Heavy Loads was submitted on June 26, 1981, and Part II of the SHNPP response was submitted on September 23, 1981. This Part II response also addressed single failure proof cranes at SHNPP. NUREG-0554, "Single Failure Proof Cranes for Nuclear Power Plants" is relevant to NUREG-0612 since use of a single-failure-proof crane precludes the analysis of heavy load drops per NUREG-0612 guidelines.

On November 27, 1984, the NRC issued its consultant's Technical Evaluation Report (TER) for the Shearon Harris Nuclear Power Plant Units 1 & 2, concluding that SHNPP "does not totally comply with the guidelines in NUREG-0612." The TER further stated that "compliance is insufficient in the following areas" and that "The main report contains recommendations which will aid in bringing...items into compliance." On March 28, 1985, CP&L provided the NRC with their responses to the TER specific concerns on the Control of Heavy Loads.

In June 1985 the NRC issued Generic Letter 85-11, "Completion of Phase II of NUREG-0612." The NRC concluded that based on the improvements in heavy loads handling achieved via

implementation of Phase I, further action was not required to reduce risks associated with the handling of heavy loads; therefore, Phase II was considered closed.

In August 1985 the NRC contracted with EG&G Idaho, Inc. to evaluate NUREG-0612 responses from nuclear plants including SHNPP Units 1 & 2. EG&G Idaho, Inc. published report EGG-HS-6990 for the SHNPP. This report concluded that SHNPP has "taken action and made commitments that will bring them into compliance with six guidelines of NUREG-0612." The one exception was "...insufficient information concerning Guideline 4 to permit adequate evaluation of Special Lifting Devices."

In June 1986, CP&L provided the NRC with additional information concerning specially designed lifting devices. This letter submitted in response to a verbal request for additional information from an NRC reviewer concerning SHNPP compliance with the operations, maintenance, testing and inspection requirements of ANSI N14.6-1978.

In April 1996 the NRC issued Bulletin 96-02 to alert licensees to the importance of complying with existing regulatory guidelines associated with the control and handling of heavy loads during plant operations and requested that each utility review plans and capabilities for handling heavy loads while the reactor is at power (in all modes other than cold shutdown, refueling, and defueled) in accordance with existing regulatory guidelines.

CP&L responded to Bulletin 96-02 in May 1996 and provided the requested review of plans and capabilities for handling heavy loads while the reactor is at power. This response included information on site procedure improvements in the movement of heavy loads over safety-related equipment.

In December 1996 the NRC requested additional information relating to Bulletin 96-02 concerning spent fuel storage casks and their associated drop analysis. Additional information requested focused on spent fuel cask crane designs, load paths, and cask loading and unloading processes. CP&L responded to this request for additional information on March 14, 1997.

Generic Issue 186, "Potential Risk and Consequences of Heavy Load Drops in Nuclear Power Plants" was identified by Nuclear Reactor Regulation (NRR) in April 1999. The concern was raised that licensees operating within the regulatory guidelines of Generic Letter 85-11 may not have taken adequate measures to assess and mitigate the consequences of dropped heavy loads. A comprehensive analysis of U.S. nuclear industry crane operating experience was conducted and documented in NUREG-1774 "A Survey of Crane Operating Experience at U.S. Nuclear Power Plants from 1968 through 2002."

The NRC issued Regulatory Issue Summary (RIS) 2005-25, "Clarification of NRC Guidelines for Control of Heavy Loads" in October 2005 and Supplement 1 in May 2007 to clarify guidance related to the control of heavy loads as a result of recommendations developed through Generic Issue 186. These RISs did not require any action or written response on the part of CP&L or SHNPP.

In September 2007 the Nuclear Energy Institute (NEI) initiated Project 689 "Industry Initiative on Heavy Load Lifts." This initiative was in response to utility and NRC staff concerns regarding the interpretation and implementation of regulatory guidance associated with heavy load lifts.

In July 2008 NEI released NEI 08-05, "Industry Initiative on Heavy Load Lifts." This formal industry initiative specified actions that each plant will take to ensure that heavy load lifts continue to be conducted safely and that plant licensing bases accurately reflect practices.

In December 2008 the NRC issued RIS 2008-28, "Endorsement of Nuclear Energy Institute Guidance for Reactor Vessel Heavy Load Lifts" to notify the industry of methods approved by the NRC staff for evaluating changes to a facility's licensing basis related to reactor vessel head and other heavy load lifts.

9.1.5.2 Safety Basis

The Safety Basis of the overhead heavy load systems are to assure:

a) the potential for any crane load drop is extremely small,

b) the handling of spent fuel shipping casks will not impact stored spent fuel because of engineered safety features, safe load paths, and storage pool isolation,

c) in the event of an Integrated Reactor Vessel Head (IRVH) drop, the integrity of the reactor vessel is not jeopardized and the reactor core remains covered and cooled.

9.1.5.3 Scope of Heavy Load Handling Systems

All cranes and hoists that lift heavy loads over spent fuel or safe shutdown equipment comply with the guidelines of NUREG-0612 and are consistent with HNP's responses and commitments related to the handling of heavy loads.

9.1.5.4 Control of Heavy Loads Program

HNP has procedures controlling the lifting and rigging of Heavy Loads. These procedures provide program guidance for the operations, testing, maintenance, and inspections of cranes and special lifting devices. In addition, these procedures provide program guidance for the identification, inspection, and application of material handling attachments. These procedures also contain the defined safe load paths for various site cranes and heavy loads.

HNP maintains a lifting program to minimize the potential for adverse interaction between overhead load handling operations and: 1) nuclear fuel assemblies to ensure a subcritical configuration and preclude radiological consequences and; 2) structures, systems and components (SSCs) selected to ensure safe, cold shutdown of the plant following a postulated heavy load drop event.

A "heavy load" is defined as one weighing 2300 pounds or more, based on the combined weight of a single spent fuel assembly and its associated handling tool. The objective of the program is to ensure that all load handling systems are designed, operated, and maintained such that their probability of failure is uniformly small and their use is appropriate for the critical tasks in which they are employed.

9.1.5.4.1 HNP Commitments in Response to NUREG-0612, Phase I Elements

HNP responded to Phase I of Generic Letter 81-07 in 1981, which requested that each utility evaluate their plants against the guidance of NUREG-0612 and provide the NRC information related to heavy loads at their facility. The NRC issued its consultant's Technical Evaluation Report (TER) for the Shearon Harris Nuclear Power Plant Units 1 & 2 in 1984 that evaluated HNP's compliance with the guidelines in NUREG-0612. In March 1985 CP&L provided the NRC with their responses to TER specific concerns on the Control of Heavy Loads. The responses and commitments from this correspondence have been captured in plant procedures and processes to ensure compliance with each of the NUREG-0612, Section 5.1.1 guidelines. These guidelines are summarized below:

Guideline 1 - Safe Load Paths

Safe load paths for the movement of heavy loads in the Reactor Containment Building, Fuel Handling Building, Fuel Unloading Building and Turbine Building are detailed in plant procedures. Safe load paths follow the safest and shortest routes with consideration given to the avoidance of fuel and safety related equipment. Copies of the load path drawings are available on the operating floor for reference and use by the signalman. The Maintenance Manager or designee can approve alternate load paths and load handling areas identified on the load path drawings. If heavy loads not identified on current load path drawings must be carried over the open reactor vessel, spent fuel or operable safe shutdown equipment, prior Plant Nuclear Safety Committee approval and a license amendment or NRC review and approval must be obtained and one of the following conditions must be met.

a) Use lifting equipment (lifting apparatus and crane) with a rated capacity at least twice the load to be handled.

b) Use a four point or redundant lifting arrangement to preclude a load drop in the event of a single point failure.

Guideline 2 - Load Handling Procedures

HNP procedures for rigging and the handling of heavy loads meet the intent of NUREG-0612, Section 5.1.1.

Guideline 3 - Qualifications, Training, and Specified Conduct of Crane Operators

Crane Operators and signalman are trained, qualified and instructed to conduct themselves in accordance with the requirements of ANSI B30.2 - 1976. Plant procedures reflect the requirement of ANSI B30.2 - 1976 including the manner in which the crane operators and signalmen qualification records will be maintained.

Guideline 4 - Special Lifting Devices

The Special Lifting Devices as described by ANSI N14.6 - 1978 are identified at HNP as the Internals Lift Rig and the Spent Fuel Storage Rack Lifting Rig. HNP had originally identified the Turbine Rotor Lifting Rig as a Special Lifting Device but due to the cancellation of Unit 2, a turbine rotor load drop affecting safety related equipment was no longer a credible scenario. Therefore, the Turbine Rotor Lifting Rig is no longer considered as a Special Lifting Device.

While HNP inspection and maintenance programs for Special Lifting Devices meet the intent of ANSI N14.6 and provide a high degree of confidence in their load handling capabilities, the exceptions to ANSI N14.6 that HNP has taken are captured in plant procedures.

Guideline 5 - Lifting Devices (not specifically designed)

All slings used in the moving of heavy loads at HNP meet or exceed the requirements of ANSI B30.9 - 1971. Slings utilized for lifting heavy loads are sized for a load rating that includes the sum of static and dynamic loading conditions. Slings and other lifting devices are inspected and maintained in accordance with plant procedures.

Guideline 6 - Cranes (Inspection, Testing, and Maintenance)

HNP cranes are inspected, tested, and maintained per ANSI B30.2 Chapter 2.2 except where it is not practical to meet the frequency of B30.2 for periodic inspections and tests. Tests and inspections should be performed before crane use unless the frequency of crane use is less than the specified test and inspection frequency or where an increased frequency is required for "critical lifts" by the Nuclear Electric Insurance Limited - Loss Control Standards. Crane inspection, testing, and maintenance at HNP are in compliance with the Occupational Safety and Health Standards, Section 179 of 20 CFR 1910.

Guideline 7 - Crane Design

Crane design at HNP is consistent with the guideline of NUREG-0612 in that it meets the applicable criteria and requirements of ANSI B30.2 Chapter 2.2 or CMAA-70. HNP Control of Heavy Load correspondence and associated attachments show crane design compliance with ANSI B30.2 or CMAA-70.

9.1.5.4.2 Reactor Pressure Vessel Head (RPVH) Lifting Procedures

For Integrated Reactor Vessel Head (IRVH) lifts, HNP procedures are used to control the lift and replacement of the reactor vessel head. These procedures establish limits on load height, load weight, and medium present under the load. These procedures:

1) use the guidance and acceptance criteria in NEI 08-05 Industry Initiative on Control of Heavy Loads, references 9.1.5-30 and 9.1.5-31,

2) provide additional assurance that the core will remain covered and cooled in the event of a postulated IRVH drop.

The HNP IRVH Drop Analysis is summarized in Westinghouse calculation CN-MRCDA-09-21 which has been incorporated into site calculation HNP-C/STRU-1117 "IRVH Load Drop Analysis".

9.1.5.4.3 Single Failure Proof Cranes for Spent Fuel Casks

Spent Fuel Cask movements are described in Section 9.1 and 15.7.5 of the FSAR. Design of the Fuel Handling Building and the Spent Fuel Cask Handling Crane prevents the possibility of the cask passing over or falling into any fuel pool.

9.1.5.5 Safety Evaluation

The HNP Lifting Program provides a defense-in-depth approach which ensures that all load handling systems are designed, operated, and maintained such that the probability of their failure is very small and that the risks associated with the movement of heavy loads is evaluated and controlled by site procedures. HNP procedures that lift and replace the IRVH provide restrictions on the maximum load height and weight which help ensure that the reactor core remains covered and cooled when an IRVH drop is postulated.

REFERENCES: SECTION 9.1

9.1.2-1 USNRC, "OT Position for Review and Acceptance of Spent Fuel Storage and Handling Applications," dated April 14, 1978, and Addendum dated January 18, 1979.

9.1.3-1 ESR 9600217, "Single Failure Analysis for the Spent Fuel Pool Cooling System."

9.1.3-2 Deleted by Amendment No. 51

9.1.3-3 ESR 9500425, "Harris SFP "C" and "D" Activation Project--SFP pools"

9.1.3-4 ESR 9800219, "Harris SFP "C" and "D" Activation Project--CCW connect"

9.1.3-5 ESR 0000286, "SFP Heatload Analysis for RFO-10 and Cycle 11"

9.1.4-1 "NRC Bulletin 96-02 "Movement of Heavy Loads Over Spent Fuel, Over Fuel in the Reactor Core, or Over Safety-Related Equipment, 30 Day Response." Serial: HNP-96-086, Dated May 13, 1996.

9.1.5-1 Letter from NRC to CP&L, dated May 17, 1978.

9.1.5-2 Letter from NRC to CP&L, dated June 12, 1978.

9.1.5-3 NUREG-0612, "Control of Heavy Loads at Nuclear Power Plants," July 1980.

9.1.5-4 NUREG-0554, "Single Failure Proof Cranes for Nuclear Power Plants," May 1979.

9.1.5-5 Letter from NRC to CP&L, dated December 22, 1980, "Control of Heavy Loads,"

9.1.5-6 Letter from NRC to CP&L, dated February 3, 1981, "Control of Heavy Loads, Generic Letter 81-07."

9.1.5-7 Letter H-X-0660, CP&L to NRC, dated June 26, 1981, "Control of Heavy Loads."

9.1.5-8 Letter from CP&L to NRC, dated September 23, 1981, "Control of Heavy Loads."

9.1.5-9 Letter from NRC to CP&L, dated November 27, 1984, "Control of Heavy Loads - NUREG-0612."

9.1.5-10 Letter NLS-85-081, CP&L to NRC, dated March 28, 1985, "Control of Heavy Loads."

9.1.5-11 Letter NLS-85-420, NRC to CP&L, dated June 28, 1985, "Completion of Phase II of Control of Heavy Loads at Nuclear Power Plants" NUREG-0612 (Generic Letter 85-11).

9.1.5-12 Letter NLS-85-032, CP&L to NRC, dated January 30, 1985, "Control of Heavy Loads."

9.1.5-13 Letter NLS-96-139, CP&L to NRC, dated June 2, 1986, "Control of Heavy Loads."

9.1.5-14 Generic Letter 96-02, "Movement of Heavy Loads Over Spent Fuel, Over Fuel in the Reactor Core, or Over Safety-Related Equipment," dated April 11, 1996.

9.1.5-15 Letter HNP-96-086, CP&L to NRC, dated May 13, 1996, "NRC Bulletin 96-02, "Movement of Heavy Loads over Spent Fuel, Over Fuel in the Reactor Core, or Over Safety-Related Equipment, 30 Day Response."

9.1.5-16 Letter from NRC to SHNPP, dated December 5, 1996, "Request for Additional Information Related to Bulleting 96-02, Movement of Heavy Loads Over Spent Fuel, Over Fuel in the Reactor Core, or Over Safety-Related Equipment."

9.1.5-17 Letter HNP-97-057, CP&L to NRC, March 14, 1997, "Request for Additional Information Related to Bulletin 96-02, Movement of Heavy Loads Over Spent Fuel, Over Fuel in the Reactor Core, or Over Safety-Related Equipment."

9.1.5-18 Generic Issue 186: Potential Risk and Consequences of Heavy Load Drops in Nuclear Power Plants.

9.1.5-19 NUREG-1774 July 2003, "A Survey of Crane Operating Experience at U.S. Nuclear Power Plants from 1968 through 2002."

9.1.5-20 NRC Regulatory Issue Summary 2005-25: Clarification of NRC Guidelines for Control of Heavy Loads.

9.1.5-21 NRC Regulatory Issue Summary 2005-25, Supplement 1: Clarification of NRC Guidelines for Control of Heavy Loads.

9.1.5-22 NEI Project 689, "Industry Initiative on Heavy Load Lifts."

9.1.5-23 NEI 08-05, "Industry Initiative on Heavy Load Lifts."

9.1.5-24 NRC Regulatory Issue Summary (RIS) 2008-28, "Endorsement of Nuclear Energy Institute Guidance for Reactor Vessel Heavy Loads Lifts."

9.1.5-25 MMM-020 "Operations, Testing, Maintenance, and Inspections of Cranes and Special Lifting Devices."

9.1.5-26 ANSI Standard B30.2 - 1976 "Overhead and Gantry Cranes."

9.1.5-27 ANSI Standard N14.6-1978 "Standard for Special Lifting Devices for Shipping Containers Weighing 10,000 pounds (4500 kg) or More for Nuclear Materials."

9.1.5-28 ANSI B30.9 - 1971 "Slings"

9.1.5-29 OSHA Standards, Section 179 of 20 CFR 1910 "Overhead and Gantry Cranes."

9.1.5-30 CM-M0094 "Integrated Reactor Vessel Head and Upper Internals Removal."

9.1.5-31 CM-M0165 "Integrated Reactor Vessel Head and Upper Internals Installation."

9.1.5-32 CQL-89-583 from Westinghouse Electric Corporation dated November 3, 1989

9.1.5-33 CQL-89-561 from Westinghouse Electric Corporation dated August 24, 1989

9.1.5-34 CQL-7417 from Westinghouse Electric Corporation dated June 8, 1983

9.1.5-35 WCAP-9198 "Reactor Vessel Head Drop Analysis."

9.1.5-36 Westinghouse Calc. CN-MRCDA-09-21 "Evaluation of a Postulated Head Drop Event for Shearon Harris" dated April 20, 2009.

9.1.5-37 HNP-C/STRU-1117 "IRVH Load Drop Analysis" dated April 21, 2009.

9.1A APPENDIX 9.1A HEAVY LOAD ANALYSIS

9.1A.1 PURPOSE OF THE HEAVY LOADS ANALYSIS

The purpose of this analysis is to consider the consequences of various postulated accident cases which involve dropping the vessel upper internals for the Shearon Harris Nuclear Power Plant of Carolina Power & Light Company. The various accident cases described are considered from the critical points along its travel path to or from the internals storage stand. The reactor vessel upper internals analysis is performed in accordance with the guidelines of NUREG-0612 "Control of Heavy Loads at Nuclear Power Plants."

9.1A.2 SUMMARY OF RESULTS

For the heavy loads analysis of the Shearon Harris Nuclear Power Plant, a drop of the upper internals is postulated to occur during refueling. In all of the possible drop scenarios considered, it is postulated that failure of the polar crane occurs, and the upper internals assembly falls onto the reactor vessel.

The results of the upper internals drop analysis indicated that the deformation and stresses at impact are within the acceptable limits; and the integrity of fuel cladding, reactor vessel nozzles, vessel supports and the core cooling capability is maintained. The maximum primary membrance plus primary bending stress intensity at the vessel nozzle and the maximum bearing stresses at the vessel nozzle support pads are 47,810 and 23,420 psi, which are well below the code allowable limits. The code allowables for the primary membrane plus primary bending (i.e., $P_m + P_b$) and the bearing stresses during faulted conditions are limited to 3.6 Sm (99,360 psi) and $2\sigma_y$ (100,000 psi), respectively.

9.1A.3 ASSUMPTIONS

The analysis performed herein is conservative since it maximizes the impact energies of the system for various postulated accident conditions. Key elements of the assumptions made are:

a) Skin frictional drag of an accelerating body through water is neglected.

b) For a free drop through air and water, the resistive impulse force due to impact with water is neglected. Further, the hydrodynamic drag force is calculated using a conservative estimate of drag coefficient (i.e., Cd = 0.5).

c) Only one-half of the buoyant force is taken into account when more than half of the assembly is submerged in water.

d) Impacting mass of the upper internals assembly is assumed to be rigid and no allowance is taken for its flexibility at impact.

e) Lift rig guide bushings do not bind with the vessel guide studs and consequently no credit is taken for frictional losses.

f) Buckling of vessel guide studs is assumed to have an insignificant effect on the upper internals assembly as it drops.

g) The drop of upper internals assembly onto the reactor vessel is assumed to be concentric. The concentric drop configuration is the limiting condition for loading the reactor vessel nozzles and supports, since in a non-concentric drop most of the impact would be taken by the refueling cavity floor and steel liner.

9.1A.4 METHODS OF ANALYSIS

9.1A.4.1 Impact and Sudden Loading

Assuming that the stresses due to impact are distributed throughout any elastic body exactly as in the static loading, it can be shown that the vertical deformation δ_i and stress σ_i due to impact produced in any such body (bar beam, truss, etc.) by vertical impact of a body falling from a height h; are greater than the deformation δ_{st} and stress σ_{st}, produced by the weight of the body applied as static load by the ratio (Reference 9.1A.4-1):

$$\frac{\delta_i}{\delta_{st}} = \frac{\sigma_i}{\sigma_{st}} = 1 + \sqrt{1 + 2\,\frac{h}{\delta_{st}}} \qquad (1)$$

where

δ_i and σ_i are deformation and stress due to impact and δ_{st} and σ_{st} are deformation and stress due to static loading .

Note that if h = 0, we have the case of sudden loading, and $\frac{\delta_i}{\delta_{st}} = \frac{\sigma_i}{\sigma_{st}}$ = 2.

9.1A.4.2 Energy Losses

The above approximate relationship of Eqn. (1) is derived on the assumption that impact strains the elastic body in the same way (though not in the same degree) as static loading and that all the kinetic energy of the moving body is expended in producing this strain. Actually; in the impact, some kinetic energy is dissipated; and this loss, which can be found by equating the momentum of the entire system before and after impact; is most conveniently taken into account by multiplying the available energy by a factor k, the value of which is as:

A moving body of mass M strikes axially one end of a bar of mass M, the other end of which is fixed. Then the dissipation factor K is:

$$K = \frac{1+1/3\ \frac{M_1}{M}}{\left(1+1/2\frac{M_1}{M}\right)^2} \qquad (2)$$

If there is a mass of M2 attached to the struck end of the bar, then

$$K = \frac{1+\frac{1}{3}\ \frac{M_1}{M}+\frac{M_2}{M}}{\left(1+1/2\frac{M_1}{M}+\frac{M_2}{M}\right)^2} \qquad (3)$$

using the dissipation factor K, an estimate of the impact energy can be made.

9.1A.4.3 Equation of Motions in the Fluid Medium

The equation of motion that describes the travel of a body through fluid media is derived from the balance of forces, i.e.,

$$\sum F = \frac{W}{g_c}\ \frac{dV}{dt} \qquad (4)$$

or

$$\left(\frac{MV}{g_c}\right)\ \frac{dV}{dy} = W - \ F_B - \left(\frac{C_D \rho_W A_P}{2g_c}\right)\ V^2 \qquad (5)$$

where

W	=	Weight of the Body
F_B	=	Total Buoyant Force
C_D	=	Drag Coefficient
ρ_W	=	Density of Water

Solution of Eqn. (5) yields the velocity for impact.

9.1A.5 POSTULATED DROP SCENARIOS AND THEIR CONSEQUENCES

In evaluating the consequences of the upper internals drop analysis for the Shearon Harris Nuclear Power Plant, a series of drop scenarios are postulated. In the following we shall discuss briefly the drop scenarios and their consequences.

Scenario (1)

The upper internals lift rig is removed from the storage stand using the polar crane and lowered over the guide studs. While the lift rig is at its maximum height from the vessel flange surface, the polar crane is assumed to fail and the weight of the lift rig and the weight of polar crane lower block assembly drops onto the vessel.

If the bushings on the lift rig engage the vessel guide studs during the concentric drop, the drop weight of the polar crane lower block could impact the control rod drive shafts.

Consequence:

The assembly weight of 26,850 lb_f falls 10.2 feet through water to impact the control rod drive shafts. Some of the kinetic energy will be expended to buckle the control rods and the rest will be absorbed by the upper internals assembly at impact. The maximum load that can be experienced by the fuel assemblies would be the buckling load of the control rods which is significantly small (i.e., 5050 lb_f) and does not cause any damage to the fuel assemblies (Reference 9.1A.5-1).

Scenario (2)

If in Scenario (1), the guide bushings do not engage the vessel guide studs, the drop weight of the assembly could impact either the guide studs or the control rod drive shafts or both.

Consequence:

Same as in Scenario (1).

Scenario (3)

Upper internals assembly is lifted up from the reactor vessel for removal. When the guide bushings reach the top of the vessel guide studs, the polar crane fails and the weight of the assembly consisting of upper internals, lift rig and the crane lower block falls onto the reactor vessel flange.

Consequence:

Scenario (4) is more limiting.

Scenario (4)

This scenario is similar to the above Scenario (3), except that the upper internals assembly is lifted further up so that the upper support plate reaches the height of water level in the refueling

cavity. It is assumed that the bushings engage the vessel guide studs and the assembly has a concentric drop of the vessel flange.

Consequence:

The assembly weight of 140,000 lb_f falls 23.75 feet through water and impacts on the top of the core hold down spring and core barrel flange assembly which is supported at the vessel ledge. The idealized spring mass system of the struck body (i.e., core hold down spring, barrel flange, vessel and nozzle supports) is able to absorb all the kinetic energy of the dropped assembly without over stressing the system. The calculated impact load at each nozzle is 7.3×10^6 lb_f resulting in vessel nozzle pad bearing stress to be 23,400 psi which remains elastic and is well below the code allowable of $2\sigma_y$ = 100,000 psi.

Scenario (5)

In Scenario (4), the control rod drive shafts will experience the same drop velocity as the upper internals assembly and could impact the fuel assembly nozzle spider hub.

Consequence:

The kinetic energy of control rod drive shaft at the time of impact is significantly less than the energy absorption capacity of the fuel assembly; and consequently no damage occurs to the fuel assembly.

Scenario (6)

In Scenario (4), it is assumed that the guide bushings on the lift rig do not engage the vessel guide studs. For the case when bushings do not engage the guide studs, the dropped weight of the assembly could impact the vessel guide studs and then impact the vessel flange.

Consequence:

In this scenario, some of the kinetic energy of the system will be expended in buckling the guide studs and the dropped mass will impact the vessel flange with less impact velocity as compared to the above case and, therefore, Scenario (4) is more limiting.

Scenario 7

In Scenario (4), it is assumed that after the bushings engage the vessel guide studs, the upper internals assembly rotates, losing the alignment with the head vessel alignment pins, upper core plate alignment pins and the fuel assembly nozzle.

Consequence:

The assembly weight of 140,000 lb_f would impact the four head vessel alignment pins and deform them plastically to absorb the total impact energy. The total deformations of the head vessel alignment pins precludes the upper core plate impacting the fuel assembly spider hub. Consequently, fuel assemblies do not see any load.

REFERENCES: APPENDIX 9.1A

9.1A.2-1 Roark, R. L., "Formulas for Stress and Strain," McGraw Hill Book Company.

9.1A.5-1 Simom, A. E., and Eng., G. H., "Fuel Rod and Fuel Assembly Mechanical Tests," WCAP-7687; March 1971.

9.2.1 SERVICE WATER SYSTEM

9.2.1.1 Design Basis

The Service Water System (SWS) is designed to operate continuously during normal, shutdown, and accident operating modes. The system is designed to:

a) Provide cooling water at a maximum temperature of 95 F to remove plant heat loads by utilizing the Cooling Tower and associated components during normal and shutdown operation;

b) Provide cooling water at a maximum temperature of 95 F to remove essential plant heat loads by utilizing the Auxiliary Reservoir or its backup, the Main Reservoir, during emergency operation;

c) Isolate non-essential cooling loads from essential cooling loads during conditions which could otherwise compromise the system safety function;

d) Provide a heat sink for essential loads assuming a single active or passive component failure;

e) Withstand or be protected from the effects of a safe shutdown earthquake, a design basis tornado, maximum flood levels, a high energy line break(s) without loss of safety function;

f) Provide essential cooling services assuming a loss of offsite power in conjunction with any event in d) or e);

g) Allow periodic testing and inspection of equipment to assure system integrity and capability; and

h) Provide for detecting, controlling, and isolating radioactive leakage into and out of the system.

9.2.1.2 System Description

The Service Water System shown on Figures 9.2.1-1 and 9.2.1-2 consists of two normal service water pumps, two emergency service water pumps, two service water booster pumps, associated piping, valves and instrumentation.

During Unit start-up, shutdown, and normal operation, service water requirements will be met by one of the normal service water pumps. The pump furnishes all normal operating service water requirements for the Unit through a single supply line. Table 9.2.1-1 lists the normal service water loads and their water requirements. The normal service water pumps take suction from

the circulating water cooling tower basin. The heated service water is returned to the Cooling Tower via the circulating water return pipes.

The natural draft, hyperbolic type Cooling Tower basin temperature will be approximately 95°F. Cooling Tower makeup flow and Cooling Tower basin flow combine to provide water below the maximum design temperature of 95 F before return to the Service Water System. Makeup for cooling tower evaporative losses and cooling tower blowdown is provided from the Main Reservoir by means of makeup pumps. When operable, the Cooling Tower can provide cooling water for Unit shutdown without reliance on the Main or Auxiliary Reservoirs. During shutdown, the cooling tower evaporative losses are sufficiently low so that makeup to the Cooling Tower will not be required.

Under accident conditions, service water will be provided by the emergency service water pumps. Only equipment essential to safe plant shutdown will be supplied. Table 9.2.1-1 shows the emergency service water loads and their water requirements. Service water will also be provided by the emergency service water pumps when needed due to temporary plant conditions or activities that are critical to plant operation. This includes for example, high Containment Building or BOP-system temperatures during hot weather periods, system testing, RCB personnel entries, or periods when the cooling tower is inoperative.

During emergency operation the ultimate heat sink dissipates the service water system heat load. The UHS (ultimate heat sink) has two alternate sources of cooling water, the Auxiliary Reservoir and the Main Reservoir. The Auxiliary Reservoir is the primary source of cooling water. When the level in the Auxiliary Reservoir is low, the suction of the emergency service water pumps is manually switched to the Main Reservoir (Section 9.2.1.3.1). In both cases the heated water is discharged to the Auxiliary Reservoir. Water supplied by the Main Reservoir is recirculated to the Main Reservoir over the Auxiliary Dam spillway. The UHS is described in Section 9.2.5.

"Water from both the Main and Auxiliary Reservoirs passes through concrete intake structures. Each structure consists of bays separated by concrete walls. Two bays are equipped with traveling screens. The SHNPP utilizes two Emergency Service Water pumps. These pumps are located in dedicated bays in the Emergency Service Water and Cooling Tower Makeup Intake Structure." Each pump discharges into a separate pipeline. Water from the plant is returned to the Auxiliary Reservoir over a weir located in an Emergency Service Water Discharge Structure. Figures 3.8.4-25 through 3.8.4-31 show the general arrangement of the intake structures including the emergency service water pumps, the traveling screens and the screen wash pumps, and the reservoir minimum and maximum water levels.

The emergency service water intake and discharge structures, the emergency service water pumps with associated piping and valves, and two redundant loops serving the essential plant components are designed to Seismic Category I requirements. See Section 3.2, Section 3.8.4, and Figures 9.2.1-1 and 9.2.1-2 for identification of Seismic Category I structures and components. All other parts of the Service Water System are not Seismic Category I and will be automatically isolated during emergency operation by valves located in the Seismic Category I piping.

The Service Water System is monitored and operated from the Control Room. Isolation valves are incorporated in all service water lines penetrating the Containment. Flow, pressure, and temperature monitoring instrumentation is provided to alert the operator on a loss of water in the

system supply lines. The display instrumentation for this system is listed in Table 7.5.1-4. System controls, including transfer from normal to emergency operation is described in 7.3.1.5.2.

Ice formation in the intake channels is not expected to be severe enough under any circumstances for this locality to jeopardize proper operation of the Emergency Service Water System. Ice effects and protection of the intake structures against icing are discussed in Section 2.4.7.

Those portions of the service water system piping in the Emergency Service Water Screening Structure and Emergency Service Water and cooling Tower Makeup Water Intake Structure which are exposed to the outdoor elements are heat traced and insulated. Since the heat tracing is required only to maintain the essential portions of the Service Water System in a condition of readiness prior to system use, the heat tracing is not safety related nor is it connectable to the onsite emergency power supply. Trouble with the heat tracing will be alarmed in the Waste Processing Control Room (refer to Section 7.7.1.11).

The safety related containment fan coolers are supplied by individual lines from the reactor auxiliary building service water header. Each inlet line is provided with a motor-operated shutoff valve and a manual drain and vent valve. Similarly, each discharge line from the cooler is provided with a motor-operated shutoff valve. This allows each cooler to be isolated individually for leak testing of the system. The motor-operated shutoff valves shall be positioned per Table 6.2.4-1 during the integrated leakage tests of the Containment. The motor-operated valves on the fan cooler inlet and outlet lines are normally open and are remotely controlled from the Control Room with status indication provided at each control module.

Under accident conditions two booster pumps (one on each of the supply lines to containment fan coolers) in conjunction with containment fan cooler orifice bypass valves shut will maintain the service water pressure inside the coolers above the containment design pressure to prevent leaks into the Service Water System. The booster pumps are not required during normal plant operation.

The requirements for water supply to the Seismic Category I portions of the Fire Protection System are described in Section 9.5.1.

The Service Water System is comprised of the following components. The component parameters are given in Table 9.2.1-2.

a) Normal Service Water Pumps - Two 100 percent capacity pumps are provided with one pump normally supplying all service water requirements. One single supply header will normally furnish the two redundant loops serving the essential plant components. Pumps are sized such that the water requirements for Unit start-up and normal operation can be met by one pump. Both pumps may be required after four hours have elapsed from the plant normal shutdown initiation (see Table 9.2.1-1). In this case both loops serving the essential plant components will be in service.

b) Emergency Service Water Pumps - There are two 100 percent pumps. Each pump supplies one of the redundant loops serving the essential plant components. Pumps are vertically mounted, motor driven units. The pumps are sized so that the water

requirements for Unit shutdown can be met by one pump, as indicated in Table 9.2.1-1. Both pumps may be used to shorten the cooldown time.

c) Service Water Booster Pumps - One horizontal, centrifugal, motor-driven pump is installed in each loop on the supply line to two containment fan coolers. During emergency operation these pumps in conjunction with the containment fan cooler orifice bypass valves shut will maintain the service water pressure inside the coolers above the containment design pressure to prevent radioactive leaks into the Service Water System. These pumps will also provide the water supply for the Post-SSE Fire Protection Standpipe and Hose System as required.

d) Self-Cleaning Strainers - One automatic self-cleaning strainer is installed in the discharge piping of each emergency service water pump. These self-cleaning strainers prevent heat exchangers in the Emergency Service Water System from clogging by preventing debris larger than 1/16 in. from entering the system.

e) Intake Screening Structure Traveling Screens - One traveling screen is installed in each operational bay of the intake screening structures (Figures 3.8.4-27 and 3.8.4-30).

   The traveling screens and their supports are Seismic Category I. They are designed to withstand the SSE combined with design load without exceeding 90 percent of yield, and the OBE loading combined with design load with no increase in allowable stress. Design load consists of a head differential of 5 ft. and the forces induced by initial movement of the screen when loaded against the 5 ft. head differential at normal water level. In addition, all components are designed to withstand the maximum of either a head differential of 10 ft. or 1/3 maximum postulated depth of water in chamber with seismic load acting concurrently without exceeding the allowable yield stress of materials.

The following additional provisions are made to control the buildup and size of debris:

1) Differential water level alarm will be provided in the Main Control Room via the computer when a high-high differential head of water is reached.

2) Size of debris is limited by course screens provided upstream of the traveling screens.

3) Ice buildup on the traveling screens is prevented by use of a heated and insulated hood, and by continuously running the screens when icing conditions exist.

Based on the design criteria specified for the traveling screens and the safeguards provided against debris buildup, collapse of the screens will not occur.

Guides for fine screens (non-traveling) are provided downstream of the traveling screen. The fine screens are designed to the same criteria as the traveling screens and are used only for limited time periods during out of structure maintenance of the traveling screens.

Screen wash water is provided by the Screen Wash System using water taken from the discharge of the emergency service water pumps. Screen wash pumps are used to boost the pressure to that required at the screen wash nozzles. An independent regulating system is provided for each screen. An additional non-safety supply of screen wash water to the

Emergency Service Water traveling screens is available from the Cooling Tower Make-up Screen Wash System. This alternate supply of screen wash water will not permit Emergency Service Water to be considered operable, but can be used to supply wash water to prevent screen clogging for certain plant configurations supporting maintenance, etc.

During normal plant operation, the traveling screens may be powered by the plant normal power system via the emergency buses. During a plant emergency, the power to the traveling screens will be automatically connected to the emergency buses.

9.2.1.3 Safety Evaluation

9.2.1.3.1 Availability and Reliability

The piping and components of the Service Water System up to and returning from the isolation valves which separate the emergency service water header from the normal service water header are not designated as nuclear safety class or Seismic Category I. The non-Seismic Category I, non-safety class portion of the Service Water System is not considered available during accident and emergency conditions and no credit is taken in the safety evaluation for this portion of the system.

Protection of safety related systems, structures and components, which includes the safety related portions of the Service Water System from the effects of natural and accidental phenomena are discussed in the following sections:

a) Tornado Wind — Section 3.3.2

b) Hurricane Wind — Section 3.3.1

c) Flooding — Section 3.4.1

d) External and Internal Missiles — Section 3.5

e) Pipe Whip — Section 3.6.1

f) Jet Impingement — Section 3.6.2

Each emergency service water pump with associated booster pump and valves is connected to a separate emergency bus. The emergency buses receive power as discussed in Chapter 8. For the loss of offsite power condition the Service Water System is designed to supply cooling water to only the required essential components. Under the conditions of a concurrent loss-of-coolant accident and loss of offsite power, or main steam line break and loss of offsite power, any one of two pumps using the emergency power will be capable of supplying the required cooling capacity (Table 9.2.1-1). In the worst case (LOCA coincident with a loss of offsite power), full service water system flow will be established approximately 80 seconds after a safety injection signal (SIS) is initiated. (The emergency service water pumps start a maximum of 22 seconds after an SIS signal). Although the service water valves have stroked sufficiently at 80 seconds to allow full flow to the containment fan coolers, a brief period of two phase flow will occur in the event of a coincident LOOP/LOCA. This two phase flow passes with full flow established to the containment fan coolers at less than 110 seconds (Reference ESR97-00125 RO). The emergency diesel generators are capable of operating at fully loaded conditions with

no cooling for a maximum of three minutes without adverse effects. Consequently, the performance of the diesel engines will not be affected by the time required to start the service water pumps, and establish system flow.

Pump performance characteristics were selected to minimize hydraulic transients. The effects of transients that may occur were analyzed to assure that system transients will have no adverse effect on system operation.

Tables 9.2.1-3 and 9.2.1-4 show the maximum SWS heat loads following a LOCA and during safe shutdown, respectively. Table 9.2.1-5 shows the total integrated heat rejection to the UHS as a function of time following safe shutdown of the plant. Design water temperatures and flowrates of all safety related heat exchangers in the Service Water System are given in Table 9.2.1-6.

The heat rejected to the Service Water System (SWS) for safe shutdown is shown in Table 9.2.1-4. The total heat rejected to the SWS includes both the sensible and decay heat rejected from the reactor coolant system, and the heat rejected from the station auxiliaries during the plant cooldown.

The sensible and decay heat rejection rate and integrated heat rejected versus time are shown in Table 9.2.1-7 for safe shutdown with offsite power not available. The decay heat generation rate was calculated by the Westinghouse "RHRCOOL" computer code which calculates the residual decay heat and RCS and CCW temperatures as a function of time during the plant cooldown transient. The RHRCOOL code incorporates decay heat data from the Westinghouse residual decay heat standard design criteria (Systems Standard No. BOP-FR-8, Rev. 1, March 1973).

The parameters used to determine the sensible heat rejection also are shown in Table 9.2.1-4. The calculation was performed assuming plant shutdown with two RHR, two component cooling water and two emergency service water trains available. This mode of shutdown results in the highest rate of heat rejection to the ultimate heat sink and consequently will result in the most critical loading condition and temperature increases for the ultimate heat sink.

The heat rejection rate and integrated heat rejected to the Emergency Service Water System from the station auxiliaries following safe shutdown of the unit are shown in Table 9.2.1-10. As indicated in Table 9.2.1-10, it has been conservatively assumed that the heat rejection rate at 4 hours following plant shutdown remains constant for the duration of plant shutdown. Table 9.2.1-4 shows the maximum instantaneous heat rejection rate to the Emergency Service Water System following safe shutdown.

The heat rejected to the Emergency Service Water System following a LOCA in the Unit (shown in Table 9.2.1-12) was determined by considering:

1) Sensible heat released during a LOCA,

2) Fission product decay heat,

3) Heavy elements decay heat, and

4) Station auxiliary heat.

The approach taken in calculating the heat rejected to the Emergency Service Water System following a LOCA has been to make conservative assumptions which maximize the total integrated heat rejected to the ultimate heat sink. The two systems available for removing heat from the Containment (items (1), (2), and (3), above) following a LOCA are the Containment Cooling System and the RHR System.

The Containment Fan Coolers will attain full heat removal capability approximately 110 seconds following the LOCA coincident with loss of offsite power. The RHR System will start removing heat from the Containment approximately 20 minutes following the LOCA (start of recirculation cooling phase). The total plant sensible heat, fission product decay heat, and heavy element decay heat rejected to the Containment Cooling System and RHR System are described in more detail in Section 6.2.1.3.

Table 9.2.1-11 shows the heat removal rate and total integrated heat removed by the Containment Cooling System and RHR System following a LOCA. Sensible heat, fission product decay heat and heavy element decay heat were all considered as energy sources.

The RHR heat exchangers in combination with the fan coolers remove all the fission product decay heat and heavy element decay heat at their generation rates. These sources are identical to those modeled for safe shutdown and are conservative compared to ANS 5.1, Reference 9.2.1-1.

Table 9.2.1-12 shows the maximum heat rejection rates and integrated heat rejected to the Emergency Service Water System from the station auxiliaries following a LOCA used for the purpose of evaluating the ultimate heat sink.

As indicated in Section 9.2.5, the estimated maximum Service Water System Inlet temperatures for the postulated conditions are 94.2°F using the Auxiliary Reservoir as the ultimate heat sink. The design inlet temperature for all equipment served by the Service Water System was chosen as 95°F. 94.2°F is acceptable as a maximum pre-accident temperature since the Ultimate Heat Sink analysis does not account for thermal stratification which would result in a maximum, post-accident (30-day) pump suction temperature below 95°F (Ref. SW-0085).

Service water to essential cooling loads, including engineered safety features equipment, will be assured despite the passive failure of any pipe or valve body or active component failure in the Service Water System. See Table 9.2.1-13 for a system failure analysis.

The line from the Auxiliary Reservoir to each emergency service water pump chamber is provided with a locked open valve. The line from the Main Reservoir to each emergency service water pump chamber is provided with a locked closed valve. This valving arrangement together with the Emergency Service Water and Cooling Tower Makeup Intake Structure provides the following:

1) The emergency pumps are normally lined up to take suction from the Auxiliary Reservoir. If necessary, the pump suction can be switched to the Main Reservoir from the Auxiliary Reservoir by opening and closing the appropriate valves. First the locked closed valve from the Main Reservoir is opened and then the locked open valve from the Auxiliary Reservoir is closed. The time to manually switch between the two sources is approximately four hours. Simultaneous open or closed positions of both valves will be alarmed in the Control Room.

2) A single failure will not siphon excessive water from the Auxiliary Reservoir to the Main Reservoir, since the reservoirs can be isolated by two butterfly valves located in each emergency service water pump bay. Redundant Class 1E, Seismic Category I level switches are provided in the pump chamber to alarm low levels on the MCB and ACP.

The flow through each containment fan cooler is measured by instrumentation which is located in its discharge line. This instrumentation includes flow sensing elements with indicators located on local racks in an accessible area and low flow alarms annunciated in the Control Room.

The flow through the component cooling heat exchangers will be measured through instrumentation which includes:

1) Flow sensing devices with indicators located on racks in an accessible area and low-flow alarms annunciated in the Control Room.

2) Temperature sensing elements with indicators located on local racks in an accessible area and high-temperature alarm devices annunciated in the Control Room.

Flows in the supply header are monitored in the Control Room by redundant channels. The pressure from the normal service water pumps is monitored in the Control Room by pressure transmitters located upstream of the emergency service water pump isolation valves (See Figure 7.3.1-15). The standby normal service water pump starts automatically to supply cooling water to the essential equipment for plant shutdown. The lineup of valves required for the switchover from the normal service water pumps to the emergency service water pumps is automatic following the startup of the emergency service water pumps. See Section 7.3.1.5.2 for a description of the instrumentation and controls for the Service Water System.

Motorized valves operate automatically or are remote manually operated from the Control Room. Manual valves are operated locally.

9.2.1.3.2 Leakage detection, isolation, and minimization

The Service Water System flow will be continually monitored by flow instrumentation located in the discharge lines. A line break upstream of the flow instrument would be indicated by a low flow reading. In addition, the discharge pressure for each pump is monitored. A major pipe break would be indicated by a low discharge pressure.

A leakage analysis assuming extensive rupture has been performed even though leaks of this size are not considered to be possible in safety class lines and highly improbable in non-safety class lines. The results of the analysis are given in Table 9.2.1-14.

An abnormal flow and temperature condition is annunciated in the Control Room by appropriate alarms, alerting the operator to the existence of a leak in the Service Water System. The specific low flow and high-temperature readings enables the operator to determine and locate the section of the Service Water System where the leak has occurred.

Small leaks which are not detectable by either of the above methods will be detected by periodic inspection of the system piping and equipment. Examples of system leakage and indicating signals are given in Table 9.2.1-14. By providing redundant methods of determining system leakage the operator is assured of a rapid detection of a major leakage or failure. The failure of

any single service water system component would not affect the capability of the system to provide the heat removal necessary for safe shutdown.

Pipe wall thickness was determined by structural integrity and not by pressure rating (i.e., pipes 10 in. NPS and smaller are standard weight as a minimum, and pipes 12 in. NPS and larger have a wall thickness of 0.375 in. even though a wall thickness of 0.23 in. is sufficient for the system design pressure of 150 psi in the largest pipe in the system). Therefore, the complete rupture of one of these lines is not considered to be a credible occurrence. The Service Water System is designed in accordance with the requirements of the codes listed in Section 3.2 with the exception of the calculation of all wall pipe thicknesses as noted above. Because of the stringent requirements of these codes, the rigorous quality assurance and stress analysis procedures applicable to these components, the increased thickness of pipe walls, and the low pressure of the system, the only leaks that might occur are small cracks which could probably be repaired without shutting down the loop. In the unlikely event a leak does occur, adequate means for detecting, locating and isolating a leak are available.

The time required to isolate a break and the quantity of water lost as a result depends on the following factors 1) size and location of the break, 2) whether the valve is manual or remotely operated, and 3) in the case of manual valves, its location.

Service water piping runs in the Reactor Auxiliary Building are kept to a practical minimum. The 236' level of the Reactor Auxiliary Building, where some of the service water piping is located, has a floor area of approximately 33,000 ft^2. This area is a conservative value based on the total floor area of the 236' level of the Reactor Auxiliary Building and the Tank Building, excluding the mechanical penetration area, but with conservative allowances for walls, columns, and equipment pedestals. All vital equipment is located on support pedestals having a minimum height of one foot. To flood this area to a depth of one foot would require approximately 220,000 gallons, assuming an occupancy factor of 10%. However, openings located on this level of the Reactor Auxiliary Building lead to a pipe tunnel, thus further increasing the amount of water required to flood this floor. The main supply and discharge lines within the Reactor Auxiliary Building run in the pipe tunnel. The tunnel extends the length of the Auxiliary Building and has instrumented sumps which will detect water leakage. The tunnel staircase is connected only with the floor above, therefore the entire tunnel must be flooded before the water could reach a floor where any equipment is located. Because the amount of water required to completely fill the tunnel is approximately 1.6 million gallons, any pipe leaks in the tunnel would be detected and isolated long before the tunnel would be completely filled. For these reasons, in the unlikely event of a major leak, no water damage to any piece of equipment is expected.

The Service Water System is designed to tolerate a single failure during the period of recovery following an accident without loss of its essential cooling capability as shown in Table 9.2.1-13.

The redundant service water lines routed between the Reactor Auxiliary Building and the Emergency Service Water and Cooling Tower Makeup Intake Structure are buried below the maximum missile penetrating depth. Therefore, no missile can jeopardize the integrity of these lines by a single event. In addition, the redundant service water lines are a nominal 10 ft. 0 in. apart on center lines and in no case closer than 9 ft. 6 in. (center to center) apart. Within the Reactor Auxiliary Building these lines enter a pipe tunnel which contains no high energy piping system. Outside the pipe tunnel, the service water system lines have sufficient separation between redundant systems to preclude damage to both systems by a single event. The entire

service water system is a moderate energy system, and therefore will not act as a potential initiator of pipe whip, jet blowdown force, or other dynamic effects.

The safety class portion of the Service Water System is designed to Seismic Category I standards, and therefore damage is not postulated under earthquake conditions.

The Emergency Service Water and Cooling Tower Makeup Intake Structure and Emergency Service Water Screening Structure are both designed to fully meet the requirements of General Design Criterion No. 4 including the dynamic effects of missiles occurring from equipment failures and from tornado generated missiles. The Service Water System is designed to withstand the wind and missile loadings associated with the design tornado together with a loss of one pump motor due to an independent single failure, without loss of capability for a safe cold shutdown.

Figures 3.8.4-25 through 3.8.4-31 illustrate the plan, front and section views of the Emergency Service Water and Cooling Tower Makeup Intake Structure and Emergency Service Water Screening Structure. As shown in the figures, equipment in the intake structure is placed in individual bays and is separated by concrete walls. This arrangement will preclude damage to more than one redundant service water system train in the event of mechanical failure of a rotating piece of equipment.

The service water system motors and associated equipment are protected against tornado missile or other missile damage. The protective structures are designed to preclude the unlikely possibility of the pump motors flooding. The essential service water system equipment is protected against failure of non-Seismic Category I equipment.

9.2.1.4 Inspection and Testing Requirements

The Service Water System will undergo preoperational testing as described in Section 14.2.12 and periodic tests as required by the Technical Specifications. Sections 6.6 for inservice inspection and 3.9.6 for pump and valve testing are applicable for the safety related portions of the system.

9.2.1.5 Instrumentation Applications

Provisions have been made to control the normal service water and emergency service water pumps from the Control Room. Each normal service water pump is interlocked with its respective discharge valve so that a pump start signal initiates valve opening and a pump stop signal initiates valve closing. Status-indicating lights are provided in the Control Room for the normal service water pump and their discharge valves.

Level and temperature indication are provided in the Control Room for the water in the normal service water pump chamber.

Flow indications are provided in the Control Room for the flow on each supply header during normal and emergency conditions.,

Automatic control is provided for the isolation of most non-nuclear safety portions of the Service Water System from the safety class portion during safety injection signal. Non-nuclear safety

portions normally supplied by ESW that do not automatically isolate are analyzed as an additional system load of 150 gpm in ESWS design calculations.

Automatic control is provided to start the emergency service water pumps upon low pressure in the emergency service water header or upon a Safety Injection Signal.

Status-indicating lights are provided in the Control Room for the emergency service water pumps and all the valves that are required to operate when the emergency service water pumps start.

Indication of the pressure at the emergency service water pump discharge is provided in the Control Room.

Alarms in the Control Room are provided to indicate the following abnormal conditions:

a) Loss of bearing flushing and cooling water to the normal and/or emergency service water pumps.

b) Trip of any pump that should be in operation.

c) Low water level in the normal service water pump chamber.

d) Low water level in the Emergency Service Water Structure.

e) Low flow at the supply header.

f) Low pressure at the normal service water pump discharge.

g) Low pressure at the emergency service water pump discharge.

h) Low flow alarm and indication for:

    1) Component cooling water heat exchanger

    2) Containment fan cooler

    3) HVAC chillers

i) The following Emergency Service Water (ESW) Screen Wash System Alarms and Status - Indicator are provided via the ERFIS computer:

    1) ESW screen wash pump status

    2) ESW screen wash supply valve status

    3) ESW traveling screen status

    4) ESW pump seal water valve status

    5) Screen differential water level alarm (high-high)

6) Proximity switch, traveling screen motion

REFERENCES: SECTION 9.2.1

9.2.1-1 American Nuclear Society Standard ANS 5.1, 1979, Decay Heat Power in Light Water Reactors.

9.2.2 COMPONENT COOLING SYSTEM

The Component Cooling Water System (CCWS) consists of two component cooling water heat exchangers, three component cooling water pumps, a component cooling water surge tank, cooling lines to various components being cooled, and the associated piping, valves, and instrumentation. It provides cooling water to various plant components during all phases of plant operation and shutdown, serving as an intermediate system between the Reactor Coolant System (RCS) and the Service Water System.

9.2.2.1 Design Basis

The CCWS is designed to operate during all phases of plant operation including startup, power operation, shutdown, refueling, and the injection and recirculation phases following a loss-of-coolant accident (LOCA).

The design of the CCWS is based on a maximum service water supply temperature of 95F.

The CCWS has been evaluated with a maximum supply water temperature of 125°F when the Residual Heat Removal System is first placed in operation during plant shutdown. This is compatible with the maximum permissible temperature of the cooling water supply to the reactor coolant pumps. CCW supply temperature is limited to 125°F during normal plant operation by controlling the cooldown rate. During normal plant operation other than plant cooldown, the temperature of the cooling water supplied to all components is a maximum of approximately 105°F.

The cooldown rate, based on reducing the temperature of the reactor coolant from 350F to 140F in approximately 25 hours is achieved using two CCWS pumps and two CCWS heat exchangers with a supply temperature of 125°F. Failure of a heat exchanger would increase the time required for shutdown but would not affect the safe operation of the plant. Failure of a pump would not affect the time required for shutdown since a standby pump is available.

The CCWS is also required for engineered safeguards operations to remove decay heat from the RCS and to provide cooling water to various engineered safeguards components. For this reason, the CCWS is designed to meet the single failure criterion by providing two completely independent parallel trains. Each CCWS train consists of a pump and heat exchanger. The surge tank is also separated into two parts by a baffle. Each train services all of the safeguards components in the appropriate safeguards train and can be isolated from the redundant CCWS train for long term post-accident recirculation. Isolation provisions are discussed in the sections on valves and on post-accident operation.

All Class 2 and 3 components of the CCWS are designed to meet Seismic Category I requirements. Equipment that is necessary for shutdown and equipment that is required to

mitigate the effects of an accident is supplied with emergency diesel power, should normal and offsite power sources fail.

9.2.2.2 System Description

The CCWS is shown in Figures 9.2.2-1 through 9.2.2-4. Design parameters for the CCWS are given in Table 9.2.2-1.

The CCWS serves as an intermediate system between the RCS and the Service Water System to ensure that leakage of radioactive fluid from the components being cooled is contained within the plant.

The system consists of two component cooling water heat exchangers, three component cooling water pumps, a component cooling water surge tank, cooling lines to the various components being cooled, and associated piping, valves and instrumentation. The component cooling water flows from the pumps, through the shell side of the component cooling water heat exchangers, through the components being cooled, and back to the pumps.

The surge tank is connected to the suction side of the component cooling water pumps. It accommodates surges resulting from component coolant water thermal expansion and contraction and accommodates water which may leak into the system from components which are being cooled. The surge tank also contains a supply of water to provide component cooling water supply until a leaking cooling line can be isolated. The surge tank water level is adjusted manually from the Control Room by delivering makeup water from the Demineralized Water System to the tank.

Water chemistry control of the CCWS is accomplished by additions to the chemical addition tank or to the surge tank. Mixing with the loop water can be accomplished by recirculation through either tank. Corrosion coupons or grab samples can be analyzed to monitor the effectiveness of the corrosion inhibitor. Periodic grab samples will be analyzed by Chemistry to ensure adequate protection is being provided to maintain the integrity of the system. Corrosion will be minimized through control of impurities and chemical additives. Adjustments will be made based upon results obtained from analyses.

Table 9.2.2-3 presents typical CCWS flow rates during normal operation.

9.2.2.2.1 Equipment served

The Component Cooling Water System provides cooling for the following heat sources:

a) reactor coolant pump motor bearing oil cooler

b) reactor coolant pump thermal barrier

c) letdown heat exchanger (Chemical and Volume Control System)

d) seal water heat exchanger (Chemical and Volume Control System)

e) excess letdown heat exchanger (Chemical and Volume Control System)

f) residual heat removal pumps (Residual Heat Removal System)*

g) residual heat exchangers (Residual Heat Removal System)*

h) recycle evaporator package (Boron Recycle System) (no longer in service)

i) reactor coolant drain tank heat exchanger (Waste Processing System)

j) spent fuel pool heat exchangers (Spent Fuel Pool Cooling and Cleanup System)*

k) sample heat exchangers (Process Sampling System)

l) gross failed fuel detector (Process Sampling System)

The residual heat removal pump coolers and heat exchangers are the essential loop defined in the Technical Specifications, and their flowpaths are the only flowpaths subject to periodic surveillances.

9.2.2.2.2 Component Description

The codes and standards to which the individual components of the Component Cooling Water System are designed and selected according to the most severe condition expected for each component either during normal operation or during operation in conjunction with the Emergency Core Cooling System. The codes selected are appropriate for the limiting conditions of operation and are consistent with the safety classifications for these components. Codes and standards applicable to the CCWS are listed in Table 3.2.1-1.

Component Cooling Water Heat Exchangers

The CCWS heat exchangers are shell and straight tube type units. Component cooling water circulates through the shell side. The shell is constructed of carbon steel and the tubes are made of 90-10 copper nickel alloy.

Each heat exchanger is designed to remove one half of the heat removal load during the period of reducing the reactor coolant temperature from 350F to 140F. The heat removal load during normal full-power operation is accommodated by one component cooling water heat exchanger with the additional exchanger providing 100 percent standby capacity. The provisions of two component cooling water heat exchangers provides redundancy required for compliance with safeguards single failure criteria, ensures that heat removal capacity is only partially lost if one exchanger fails or becomes inoperative, and permits maintenance or replacement of one exchanger while the other unit is in service.

Component Cooling Water Pumps

There are three CCWS pumps. Each pump is a horizontal, centrifugal unit with carbon steel casings, internals, and shafts. The design capacity of each pump equals or exceeds the required capacity for single pump operation during normal operation, safety injection, and post-accident recirculation on a redundant train basis.

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* Heat loads from these components are considered to be safety-related

During the plant cooldown two pumps are operated; essential loop and to the non-essential loop. The second pump is aligned to its respective essential loop only. During normal operation, only one of the component cooling water pumps is operating although two pumps are required to be available in order to supply the normal cooling water flow demands and to maintain 100 percent standby flow capacity in case the operating pump trips off. A minimum of two pumps is also required for compliance with safeguards single failure criteria. The provision of a third pump provides redundancy should one of the three pumps require preventive or corrective maintenance.

Provisions to ensure that electrical power is available to the pumps are discussed in Section 9.2.2.3.

Component Cooling Water Surge Tank

The CCWS surge tank is cylindrical, horizontal and is made of carbon steel.

The surge tank capacity permits:

a) The sure tank to accommodate changes in CCWS water volume due to changes in operating temperature.

b) A volume to accommodate, for 20 minutes, the maximum flow from either makeup water supply.

c) A reservoir of water to provide time to locate and terminate a system leak should one develop.

d) A volume to accommodate, for about 2 hours, the Technical Specification maximum identified reactor coolant leakage of 10 gpm.

The CCWS surge tank is located at an elevation that ensures adequate net positive suction head (NPSH) to the CCWS pumps.

The tank is exposed to atmospheric pressure via two vent lines, which also protects the tank from overpressurization. Orifices in the demineralized water and reactor makeup water addition lines limit the flow into the system to a maximum of 50 gpm, ensuring that the capacity of the vent lines to handle an accident mass influx from these two sources is not exceeded. The tank is connected to the system by two four (4) inch lines, both equipped with locked-open valves.

Component Cooling Water System Piping

Carbon steel is used for piping since it has good corrosion resistance when in contact with the inhibited component cooling water. All piping joints and connections are welded. Flanged connections are used at pumps, heat exchangers, valves and instrumentation connections, to facilitate removal for maintenance.

The piping of the Component Cooling Water System does not require thermal insulation since it rarely reaches a temperature higher than 150F.

Component Cooling Water System Valves/Over Pressure Protection

The majority of the valve bodies except butterfly valves and relief valves are butt welded or socket welded, carbon steel with stellite or stainless steel trim. Other valve bodies may be of stainless steel construction.

Design methods are employed to provide thermal over pressure protection of heat exchangers to relieve volumetric expansion which occurs if the CCW is isolated and the trapped CCW fluid were heated by the process fluid. Where pressure relieving devices are employed, the set pressure ensures the design pressure of the portion of the system that can be isolated is not exceeded.

The relief valve downstream of the excess letdown heat exchanger is sized to relieve flow should a tube rupture occur in the excess letdown heat exchanger. In this case the valve must relieve a water steam mixture.

A relief valve is also provided on each CCWS reactor coolant pump thermal barrier line.

The cooling water headers to the reactor coolant pumps and to the excess letdown and reactor coolant drain tank heat exchangers are provided with check valves and motor operated gate valves on the inlet lines and motor operated gate valves on the outlet lines. The gate valves on the lines to and from the heat exchangers close automatically on a Phase A containment isolation (T) signal; the gate valves on the lines to and from the reactor coolant pumps close automatically on a Phase B containment isolation (P) signal. For protection in the unlikely event of a ruptured thermal barrier cooling coil in the reactor coolant pump, each of the feedlines to the pump thermal barriers is provided with check valves and the discharge header is provided with a third motor operated gate valve that would close automatically on high discharge flow.

In order to isolate the non-essential header, four motor operated valves (two each in the CCW pump suction and discharge header) are provided so that the CCW can be remotely separated into two independent loops upon the initiation of post-accident recirculation. It is not necessary that these valves be closed during the injection phase of a LOCA.

The component cooling water to the non-safety processing sampling system (sample heat exchangers and gross failed fuel detector) is provided with two air operated valves on the inlet lines and two check valves on the outlet lines. The air operated valves on the inlet lines will close automatically on a Safety Injection (S) signal thus isolating the CCW system from non-safety related systems.

9.2.2.2.3 System Operation

Normal Operation

Normal operation includes the power generation and hot standby operating conditions when the reactor plant is at normal operating temperature and pressure.

Only one component cooling water heat exchanger and one pump are required for operation. One component cooling water pump is placed on standby to start automatically on low pressure in the component cooling water pump discharge header. The four manual valves in the component cooling pump suction and discharge cross connects are kept closed during normal

operation. These valves separate the normally operating component cooling pump from the pump providing backup. By closing them, separability is maintained in the suction and discharge headers such that complete redundancy and separation of cooling water trains for post-accident recirculation can be completed remotely from the Control Room by remotely closing the non-essential header inlet and outlet isolation valves.

Periodically, a sample of the component cooling water is taken by the plant operator to ascertain that water chemistry specifications are met. Chemicals are then added and mixed by recirculation as necessary.

The CCWS System is capable of supplying cooling water to each of the four spent fuel pool heat exchangers. This is established by appropriate flow alignment of manual isolation and throttle valves in the spent fuel pool heat exchanger cooling water supply, return, and interconnecting headers. When two spent fuel pool heat exchangers are placed in service, they are operated in parallel. In this alignment, one heat exchanger is capable of being aligned to a separate pool. The CCW system is capable of supplying two spent fuel pool heat exchangers from a single CCW pump provided that the system is balanced to provide the required flow to the RHR system and the other required CCW cooling loads.

Plant Shutdown

Plant shutdown is defined as the operations which bring the reactor plant from normal operating temperature and pressure to cold shutdown for maintenance or refueling.

As discussed in Section 5.4.7.1, the Residual Heat Removal System is placed in operation approximately four hours after reactor shutdown when indicated temperature and pressure of the RCS are less than approximately 350°F and 363 psig, respectively. The standby component cooling heat exchanger and pump are placed in operation, component cooling water flow is initiated and both residual heat exchangers of the Residual Heat Removal System are placed in operation.

The rate of heat removal from the reactor coolant is controlled by regulating the reactor coolant flow rate through the residual heat exchangers. The cooldown rate is limited by the allowable cooling rate based on stress limits of the reactor vessel and steam generator, and the limits set on the operating temperature of the Component Cooling Water System by other components using the system. During the cooldown period, the cooling water inlet temperature to the various components has been evaluated up to a 125°F supply temperature. However, normal plant operations limit the supply temperature to 105°F (refer to Table 9.2.2-1).

The spent fuel pool heat duty is supplied by the CCWS. The spent fuel pool heat exchangers are cooled by the CCWS; however, the plant cooldown time will be extended and may require termination of CCW to other non-essential equipment.

During a cold shutdown condition, residual heat from the reactor core is removed by the Component Cooling Water and Residual Heat Removal Systems. The number of pumps and heat exchangers in service varies depending upon the residual heat removal load and the spent fuel pool load.

Post-Accident Operation

During the injection phase following a LOCA the component cooling water pumps receive an "S" signal to ensure that at least one pump is started and supplying cooling flow to the safeguards pumps.

As the Safety Injection System is switched over to the recirculation phase, special preparations have to be made in the CCWS. This system is designed to be operable with a single active or passive failure during the recirculation phase. Therefore, the system must be separated into two parts, each of which can function independently and remove the residual heat from the recirculated sump water.

The separation of the system into parts consists of closing two of the four motor operated valves in the cross-connecting headers downstream of the component cooling water heat exchangers and upstream of the component cooling water pump suction header. In the event of a passive failure in the system, only one half of the system will be affected, and the second half will remain operational. In the case of an active failure of one of the pumps, the valves in the suction header and in the discharge header can be repositioned to align the spare pump with the affected half of the system.

In order to separate the trains, four motor operated butterfly valves (two on upstream of the CCW pump suction header and two downstream of the CCW heat exchanger header) are provided so that the CCW can be remotely separated into two independent loops upon the initiation of post-accident recirculation. It is not necessary to separate the trains during the injection phase of a LOCA.

The component cooling water to the non-safety processing sampling system (sample heat exchangers and gross failed fuel detector) is provided with two air operated valves on the inlet lines and two check valves on the outlet lines. The air operated valves on the inlet lines will close automatically on a Safety Injection (S) signal thus isolating the CCW system from non-safety related systems. At the initiation of ECCS recirculation when the sump temperature is approximately 244°F, the spent fuel pool heat exchanger heat load is isolated temporarily from the CCWS to reduce the overall heat load on the system. When the sump temperature has been reduced to approximately 200°F post LOCA, the spent fuel pool heat exchangers can be realigned to the CCWS.

9.2.2.3 Safety Evaluation

Safety-related portions of the CCWS are Seismic Category I design, capable of withstanding adverse environmental occurrences such as postulated earthquakes, tornadoes, and tornado missiles (Seismic Category I structures are discussed in Chapter 3.)

The CCWS serves as an intermediate system between the Reactor Coolant System and the Service Water System. The CCWS, in conjunction with the Service Water System (SWS) radiation monitors described in Section 11.5.2.7.2.1, minimize the potential for unmonitored radioactive fluid leakage from the plant to the environment.

Leakage into the Component Cooling System can be detected by either of two radiation detectors, routine sampling, high temperature, and in the case of a large leak, a rise in the surge

tank level which will initiate a high level alarm. Details of the radiation monitoring equipment are given in Section 11.5.

To assure reliability, the component cooling water pumps and the motor operated valves are connected to two separate buses so that pumps and valves performing similar functions will receive power from different sources, both when normal off-site power is available and when emergency on-site power is required. Therefore, two component cooling water pumps are connected to separate and redundant electrical power and control circuits.

See Section 8.3.1.1.2.4 for additional information on electrical connections, interlocks, and alarms.

Sufficient cooling capacity is provided to fulfill all system requirements under normal and accident conditions. Adequate safety margins are included in the size and number of components to preclude the possibility of a component malfunction adversely affecting operation of safety features equipment. A failure modes and effects analysis of the CCWS is provided in Table 9.2.2-4.

The component cooling water lines supplying the RCP motor oil coolers are ASME Class 3 and seismic Category I. During normal operation manually operated isolation and throttle valves on these lines do not require adjustment. Therefore to preclude inadvertent operator action, these valves will be locked in the throttled position. Also, RCP motor vibration detectors and alarms are available to the operators if excessive vibration were to occur.

Instantaneous seizure of a RCP motor due to a loss of CCW to the oil coolers is not considered to be a credible event. However, an evaluation of a locked rotor scenario has been completed for Shearon Harris (FSAR 15.3.3), and the radiological consequences are less than the applicable limits.

9.2.2.4 Tests and Inspections

Preoperational testing is described in Chapter 14. The performance and structural and leaktight integrity of all component cooling water system components is demonstrated by continuous operation.

The CCWS is testable through the full operational sequence that brings the system into operation for reactor shutdown and for accident mitigation, including operation of applicable portions of the protection system and the transfer between normal and standby power sources.

The safety-related components of the CCWS i.e., pumps, valves, heat exchangers, and piping are designed and located to permit (to the extent practicable) preservice and inservice inspections.

9.2.2.5 Instrumentation Requirements

The component cooling water system instrumentation provides the required signals for safe, reliable, and efficient operation and control of the system. The operation of the CCWS loops is monitored with the following instrumentation:

a) temperature detectors downstream of the component cooling water pumps and heat exchangers

b) temperature detectors in the outlet headers from the reactor coolant pumps

c) pressure detectors downstream of the component cooling water pumps and heat exchangers

d) flow indicators downstream of the component cooling water heat exchangers

e) a local flow indicator in each of the return lines from the reactor coolant pumps

f) flow indicators for cooling supplies RHR pumps to the residual heat exchangers

The previous indicators are provided with alarms on the main control board that actuate at preset limits.

Loss of component cooling water to the oil coolers of the reactor coolant pump motors will be detected by redundant safety grade flow instrumentation, which will be designed in accordance with IEEE 279. Low flow alarms will be provided to initiate manual protection of the affected reactor coolant pump(s) if component cooling water cannot be restored within ten minutes. Additional protective actions will be based on the Technical Specification requirements for operability of Reactor Coolant Loops.

A flow element is also installed in the component cooling water outlet header from the reactor coolant pumps thermal barrier cooling coils. Flow rate is indicated locally. High and low flow alarms are available, and high flow would automatically close the isolation valve.

Local flow indicators are provided in the cooling water outlet lines from the following equipment items to establish the required coolant flows:

a) Seal Water Return Heat Exchanger

b) Letdown Heat Exchanger

c) Spent Fuel Pool Heat Exchanger

d) Reactor Coolant Drain Tank Heat Exchanger

e) Excess Letdown Heat Exchanger

High and low flow alarms are provided for monitoring for gross leakage.

Local and control room indication of surge tank levels keeps the operator informed of any leakage into or out of the CCWS. High and low level signals actuate alarms if the water level is above or below the normal range. Two redundant instruments provide indication of surge tank level on either side of the baffle plate. The gross failed fuel detector is isolated on low surge tank level.

Local flow and temperature indicators are provided in the cooling water outlet lines from other equipment cooled by the CCWS. These instruments provide a means to establish the required coolant flows and to determine the component cooling water heat loads.

A radiation detector is installed in the CCWS pump discharge header. If the radiation level of the cooling water exceeds a predetermined permissible level, an alarm is actuated. Details of the radiation monitoring equipment are given in Section 11.5.

Other alarms/indicators are also available to the operator to alert him of single active failures (e.g., spurious closure of a containment isolation valve) and to determine which pump(s) should be tripped:

a) CCW containment isolation valve position indicators.

b) CCW flow alarms for each of the RCP motor oil coolers return lines (upper and lower oil cooler common return).

c) CCW temperature alarm for the common return lines from all RCP motor oil coolers.

d) RCP motor upper thrust shoe, lower thrust shoe and upper guide bearing temperature alarms via the ERFIS computer. (These bearings are served by the upper oil cooler).

e) RCP motor lower guide bearing temperature alarm. (This bearing is served by the lower oil cooler) via the ERFIS computer.

f) RCP motor winding temperature alarm via the ERFIS computer.

9.2.3 DEMINERALIZED WATER MAKEUP SYSTEMS

Makeup demineralized water is provided by the Primary Filtered Makeup Water System (FMS) and the Demineralized Water System (DWS).

9.2.3.1 Primary Filtered Makeup Water System

9.2.3.1.1 Design bases

The FMS is designed to provide filtered reservoir water of less than 0.3 NTU (Nephelometric Turbidity Unit) to the plant demineralized and potable water systems.

9.2.3.1.2 System description and operation

The FMS provides a maximum of 200 gpm of filtered water to a 500,000 gallon prefiltered water storage tank from which water is distributed to the demineralized water system as needed. The FMS obtains reservoir water from either of the SHNPP main or auxiliary reservoir. The FMS consists of a microfiltration system followed by a nanofiltration system. Both systems have redundant filtration flowpaths. Local turbidity indications on the effluent of the microfiltration system ensure water quality is less than 0.3 NTU. Backwash from both systems is discharged to the plant's neutralization basin.

9.2.3.1.3 Safety evaluation

The FMS serves no safety function since it is not required to achieve safe shutdown or mitigate the consequences of an accident. The failure of any FMS equipment cannot affect the operation of any safety related equipment.

9.2.3.1.4 Testing and inspections

The FMS can be tested by operating the valves individually via a manual override. All equipment is tested prior to initial operation to ensure the proper functioning of all components. The equipment is proven operable through normal plant operation. Periodic maintenance ensures proper operation of equipment.

9.2.3.1.5 Instrumentation application

Instrumentation for automatic control of the system is provided to achieve system operation as described in Section 9.2.3.1.2. Local and remote alarms are provided for proper operation of the system and protection of components in the system.

9.2.3.2 Demineralized Water System (DWS)

9.2.3.2.1 Design bases

The DWS is designed to provide a supply of water sufficient for the expected makeup demands used by various systems, including the Reactor Coolant System and demands for plant startup and operation with allowance for the regeneration of the demineralizers and a normal amount of downtime for maintenance.

The DWS is capable of supplying normal makeup needs with additional capacity for filling the condensate storage, refueling water storage tank and reactor makeup water storage tank, which have adequate capacity to bring the plant to a shutdown condition, if required, during accident conditions. Also demineralized water will be pumped directly to other demineralized water users as indicated on Figure 9.2.3-1.

The DWS is shown on Figures 9.2.3-1, 9.2.3-3, and 9.2.4-1. The system is designed to supply demineralized water to the 500,000 gallon demineralized water storage tank. One of two 300 gpm demineralized water transfer pumps distributes water to the following:

a) Reactor makeup water storage tank

b) Condensate storage tank

c) Refueling water storage tank

d) Miscellaneous users

The system is designed to process filtered water from the FMS to produce demineralized water at the design flow rates.

The mixed bed polishing unit is designed to polish full flow without exceeding a maximum flow of approximately 15 gpm per sq. ft. of bed area. It is also designed such that the minimum pressure at the discharge of the mixed bed is not less than 50 psig at any time during operation.

9.2.3.2.2 System Description and Operation

The DWS system consists of a double train. Each train consists of one carbon adsorption unit and three bed demineralizers. A vacuum degasifier is common to both trains. A low sodium mixed bed demineralizer downstream of the mixed bed demineralizers maintains low sodium levels in the DWST to support steam generator operations with the condensate polishers bypassed. All this equipment is located in the Water Treatment Building. The demineralized water storage tank and transfer pumps are located in the yard, along with the associated valves and piping.

Design data for principal DWS components are shown on Table 9.2.3-3.

Pretreated water flows through one or both makeup demineralizer trains to the demineralized water storage tank from which two 100 percent capacity pumps supply demineralized water to the unit.

Each train operates until a present quantity of water passes through the integrating totalizing inlet flow meter. When this preset amount of water is reached, the train will shut down and an alarm will indicate demineralizer exhaustion at the local DWS control panel.

An interlocking system is provided such that not more than one cation and one anion unit of one train is regenerated at one time. Similarly, not more than one mixed bed exchanger is regenerated at any one time.

The regenerative waste from the DWS flows into the waste neutralizing basin where the pH is adjusted and discharged to the settling basin. From the settling basin, it is pumped to the Main Reservoir. The acid and caustic storage tanks as well as the regeneration station are surrounded by a concrete basin with curb to protect nearby equipment in the event of a leak or tank rupture.

The effluent from the demineralizers is normally stored in a demineralized water storage tank. Normally, a diaphragm placed inside the tank eliminates contact between the atmosphere air and the tank contents. However, a nitrogen sparger has been placed inside the tank as a contingency against possible oxygen excursions. One 500,000 gallon capacity tank is provided. Two 100 percent capacity demineralized water transfer pumps (340 gpm each) supply demineralized water to all the users. One pump will be in continuous operation to assure demineralized water supply to the miscellaneous users at all times.

A minimum flow recirculation line with a flow control valve is provided at each pump discharge to protect the pumps during low or no flow demand of demineralized water. Level control valves in the demineralized water supply line to the Condensate Storage Tank and Reactor Makeup Water Storage Tank are available for maintaining a required water level in the tanks. The LCV for the RMWST is normally isolated to prevent overfill of the tank due to the design leakby of the LCV. The LCV could be unisolated to allow the automatic fill of the tank or isolated when the RMWST is at the required level.

If maintenance is required on the demineralized water storage tank, condensate storage tank, or the reactor makeup water storage tank, demineralized water will be bypassed around the associated tank.

9.2.3.2.3 Safety evaluation

The supply of DWS serves no safety function since it is not required to achieve safe shutdown or mitigate the consequences of an accident. Components within the DWS are relied on for Containment Isolation and therefore are Seismic Category I, Q-Class A.

9.2.3.2.4 Testing and Inspection

The DWS components are inspected and cleaned prior to installation into the system. The system is operated and tested initially to assure its proper operation, instruments are calibrated, and automatic controls are tested for actuation at the proper setpoints. The system is proven operable through normal plant operations. Periodic maintenance ensures proper operation of equipment.

9.2.3.2.5 Instrumentation application

Instrumentation for automatic control of the system is provided to achieve system operation as described in Section 9.2.3.2.2.

9.2.3.3 Primary Makeup System

9.2.3.3.1 Design basis

The Primary Makeup System (PMS) is designed to supply makeup water to the Nuclear Steam Supply System (Component Cooling Water System and Reactor Coolant System). In addition, primary water is supplied to other plant users as indicated on Figure 9.2.3-2.

9.2.3.3.2 System description

The PMS consists of the reactor makeup water storage tank, two (100 percent capacity) pumps and the associated valves and piping. Design data for principal PMS components are shown on Table 9.2.3-4.

A level control valve in the inlet line of the Reactor Makeup Water Storage Tank is available for automatically maintaining the required inventory in the tank. This LCV will normally be isolated to prevent overfill of the RMWST due to the design leakby of the LCV. When it is necessary to add water to the RMWST, the LCV can be unisolated and then isolated upon completion.

A nitrogen sparger has been placed in the reactor makeup water storage tank in order to effectively strip dissolved oxygen from the contents of the tank in the case of an excursion. The supply of nitrogen to this sparger is from the plant nitrogen system through a one-quarter inch pressure-regulating valve or from the low pressure Nitrogen Storage Tank (located at the south end of the Turbine Building) through a one-inch pressure-regulating valve. Both pressure regulating valves are nominally set at 25 psig. A six inch ASME III, Class 3 relief valve has been placed on the overflow of the tank for additional tank protection.

Two 100 percent capacity reactor makeup water pumps (150 GPM each) supply primary water to all the users. One pump will be in continuous operation to assure primary water supply to the miscellaneous users at all times. Minimum flow recirculation lines are provided at the pump discharges to protect the pumps during low flow demands of the primary water system.

The primary water supplied to the Reactor Coolant System for reactor makeup is controlled by the Chemical and Volume Control System as described in Section 9.3.4.

9.2.3.3.3 Safety evaluation

The PMS is capable of supplying normal reactor makeup needs. Additional capacity allows the use of primary water for miscellaneous users. Pneumatically operated valves of the spring loaded type which fail closed are provided for remote isolation of the nuclear safety class portion of the system that serves reactor makeup needs from the miscellaneous users (non nuclear safety class portion).

Although the makeup water system is not required for the safe shutdown of the plant, the portion of the system that is required for the Nuclear Steam Supply System makeup is designed to Safety Class 3, Seismic Category I criteria.

Protection of these safety related portions of the PMS from the effects of natural and accidental phenomena are discussed in the following sections:

Tornado Wind	Section 3.3.2
Hurricane Wind	Section 3.3.1
Flooding	Section 3.4.1
Missile Protection	Section 3.5
Protection Against Dynamic Effects Associated with the Postulated Rupture of Piping	Section 3.6

9.2.3.3.4 Testing and Inspection

Preoperational and Startup Tests are described in Section 14.2.12. Proper operation of the PMS is verified during plant operation since this system is normally in use.

9.2.4 POTABLE AND SANITARY WATER SYSTEMS

9.2.4.1 Design Basis

The Potable and Sanitary Water System (PSWS) provides the plant, including construction facilities and recreation area, and the Harris Energy and Environmental Center with water suitable for human consumption and for the operation of all sanitary plumbing fixtures and selected equipment. The PSWS provides both hot and cold water at required pressures, flow rates, and temperature. The PSWS flow diagram is shown on Figure 9.2.4-1.

9.2.4.2 System Description and Operation

A new potable water system has been placed in operation. Until the old potable water system is physically removed from the Water Treatment Building, it will remain abandoned in place. The systems will remain isolated from each other so that only one can operate at a time. Both systems will be described below.

9.2.4.2.1 Old (abandoned) System

Pretreated water as described in Section 9.2.3.1 is pumped from the pretreated water clearwell tank by the potable water pumps to the potable water treatment system in the Water Treatment Building. The filter water is chlorinated by the addition of sodium hypochlorite solution and the pH is adjusted with the addition of sodium hydroxide. The water then flows through at least two of the three automatic gravity filters, each with a capacity of 100 gpm and so designed as to permit a maximum flow rate of 2 gpm per square foot. An underdrain system is provided and is designed to distribute the influent and backwash evenly throughout the cross-sectional area of the filter. The filters are interlocked so that no more than one filter will be backwashed at any given time. Backwash action of the filters is automatically actuated by means of head pressure loss through the filter media. Filtered water in the storage compartment of the gravity filter is the backwash water source. The head loss pressure valve at which the filter backwash cycle commences is adjustable and, in addition, is provided with an optional manual initiation. The backwash cycle is completely automatic after which the filter returns to the original filtering mode of operation. The backwash water is collected in the settling basin and the supernatant water is pumped to the environment.

The filter water is pumped by the hydro-pneumatic tank pumps to the hydro-pneumatic storage tanks. Zinc addition pumps are coupled to the A, B & C trains to inhibit corrosion in the underground carbon steel portions of the system. The tanks are pressurized by the injection of air thus serving as a source of pressure for water distribution.

The potable water and distribution piping supplies water through branch lines to the site structures and the Harris Energy and Environmental Center, and the building distribution piping provides water to the following plumbing fixtures and equipment:

1) Water closets, urinals, lavatories, showers, service sinks, and hose connections
2) Drinking water coolers
3) Emergency shower and eyewash stations
4) Personnel decontamination areas
5) Laundry facilities
6) Food service equipment and kitchen units
7) Circulating water and normal service water pump bearings
8) Emergency diesel generator jacket cooling water makeup

9) Chlorination evaporators of the cooling water system

9.2.4.2.2 New System

As described in Section 9.2.3.1, water from the main or auxiliary reservoir is processed by two trains of micofiltration, then processed using a membrane based nanofiltration system to produce highly filtered water which can be routed to the Pretreated Water Storage Tank, or chemically treated and chlorinated and routed to the Potable Water Clearwell for use as site drinking and sanitary water. The Potable Water Clearwell provides a reserve volume of treated water available to the site Potable Water distribution system, and ensures that adequate chlorine contact time is achieved for disinfection. The site distribution system pressure is maintained by three repressurization pumps located on the outlet of the Clearwell.

The potable water and distribution piping supplies water through branch lines to the site structures and the Harris Energy and Environmental Center and the building distribution piping provides water to the following plumbing fixtures and equipment:

1) Water closets, urinals, lavatories, showers, service sinks, and hose connections

2) Drinking water coolers

3) Emergency shower and eyewash stations

4) Personnel decontamination areas

5) Laundry facilities

6) Food service equipment and kitchen units

7) Circulating water and normal service water pump bearings

8) Emergency diesel generator jacket cooling water makeup

9.2.4.3 Safety Evaluation

The PSWS is not cross-connected to any fixture or equipment having the potential for containing radioactive material. Therefore, there is no possibility of such contamination to the system. When the possibility of back siphonage exists, approved devices such as back flow preventers, vacuum breakers and check valves are installed in the system.

The failure of non-safety PSWS components which could affect the operation of safety related equipment (i.e., mechanical equipment and piping, HVAC ducts, electrical cable trays and conduits, instrumentation and controls) have been investigated with respect to the area of influence of the failed PSWS component. The failure of any PSWS component will not result in the failure of any safety related equipment.

9.2.4.4 Testing and Inspection

The PSWS treatment components are inspected, operated, and calibrated to assure proper operation. All portions of the piping systems are subjected to hydrostatic pressure tests or initial service leak tests to assure system integrity.

9.2.4.5 Instrumentation Application

Instrumentation for automatic control of the PSWS treatment equipment is provided to achieve system operation as described in Section 9.2.4.2. Local and remote controls are provided for monitoring of the system and protection of components in the system.

9.2.5 ULTIMATE HEAT SINK

The function of the ultimate heat sink (UHS), a complex of water sources, including associated retaining structures and any canals or conduits connecting the sources with the intake structure, is to dissipate reactor decay heat and essential cooling system heat after a shutdown following an abnormal condition including a loss-of-coolant accident.

9.2.5.1 Design Basis

The design bases for the ultimate heat sink are:

a) The ultimate heat sink has sufficient capacity to:

    1) provide a source of cooling water to the Emergency Service Water System for at least 30 days to permit safe shutdown and cooldown of the plant and to maintain it in the safe shutdown condition; or

    2) provide a source of cooling water for at least 30 days to permit emergency shutdown and cooldown of the plant and to maintain the Unit in the safe shutdown condition.

b) The 30-day cooling supply is based upon conservative assumptions of meteorological and other parameters such as solar radiation, ambient air temperature, dewpoint temperature, windspeed, rainfall, creek inflow, reservoir pumped make up, and the total heat rejected from the plant.

c) The design maximum allowable service water system inlet temperature is 95 F.

d) The ultimate heat sink is protected from or designed to withstand without loss of function, the following design basis natural phenomena:

    1) hurricane and tornado (see Sections 2.3, 3.3, 3.5, and 3.8)

    2) flood (see Sections 2.4, 3.4, and 3.8)

    3) earthquake (see Sections 2.5, 3.7, and 3.8)

    4) icing (see Section 2.4.7)

e) The ultimate heat sink is designed, as applicable, to ASME Section III, Class 3 and Seismic Category I requirements (See Section 3.2).

f) The Auxiliary Reservoir is the preferred source of cooling water for emergency operations.

The Main Reservoir serves as a backup source of water in the unlikely event of the unavailability of water from the Auxiliary Reservoir.

9.2.5.2 System Description

The ultimate heat sink for the Shearon Harris Nuclear Power Plant utilizes two alternate sources of cooling water: the Auxiliary Reservoir and the Main Reservoir. The Emergency Service Water Discharge Channel, Auxiliary Reservoir Separating Dike, Auxiliary Reservoir Channel, Emergency Service Water Intake Channel, Auxiliary Dam and Reservoir, Auxiliary Dam Spillway, Main Dam and Reservoir, Cooling Tower Make-Up Water Intake Channel, the Emergency Service Water Discharge Structure, the Emergency Service Water and Cooling Tower Makeup Water Intake Structure, and the Emergency Service Water Screening Structure constitute the ultimate heat sink complex. The dams, dike and channels are described in Sections 2.4.8, 2.5.6, and 3.8.4. The Emergency Service Water Intake, Discharge, and Screening Structures are described in Sections 9.2.1 and 3.8.4.

Under emergency conditions, the service water supply is switched from the Cooling Tower to the emergency service water pumps with preferred suction from the Auxiliary Reservoir via the Emergency Service Water Intake Channel. Should the Auxiliary Reservoir be used in this manner, the heated return water will be discharged back to the Auxiliary Reservoir and only essential cooling will be provided (i.e., all non-essential cooling loads such as the turbine building loads will be isolated).

The Main Reservoir, via the Cooling Tower Make-up Water Intake Channel, serves as a backup supply of water for the Auxiliary Reservoir. Valving is provided to switch suction from the Auxiliary Reservoir to the Main Reservoir. Cooling water supplied by the Main Reservoir is discharged to the Auxiliary Reservoir and returned to the Main Reservoir by discharge over the Auxiliary Dam Spillway. For further information and reservoir operational levels, see Section 2.4.11.

9.2.5.3 Safety Evaluation

9.2.5.3.1 Availability and Reliability

The UHS assures a redundant supply of cooling water to the Service Water System under accident conditions and is designed to satisfy the following criteria:

a) To withstand the SSE without loss of function (see Sections 2.5, 3.8, and 3.7).

b) To withstand the design basis tornado without loss of function (see Sections 3.2, 3.3, 3.5, 3.8, and 9.2.1).

c) To withstand design basis flood, rainfall, and other natural phenomena without loss of function (see Sections 2.4.4 and 2.3).

d) To have sufficient capacity and redundancy to satisfy the single failure criterion including the failure of any single man-made structure (see Section 2.4.11).

e) To be operable during loss of offsite power.

The approach taken in calculating the heat rejected to the plant cooling water systems following a LOCA is based on conservative assumptions which maximize the total integrated heat rejected to the ultimate heat sink. See Section 9.2.1 for details. The same information is used in the ultimate heat sink dependability evaluation discussed in Section 2.4.11. Based on this evaluation, the maximum emergency service water system inlet temperature for the postulated conditions 94.2°F and occurs when using the Auxiliary Reservoir as the ultimate heat sink. The ESW design basis maximum water temperature is 95°F. 94.2°F is acceptable as a maximum pre-accident temperature since the Ultimate Heat Sink analysis does not account for thermal stratification which would result in a maximum, post-accident (30-day) pump suction temperature below 95°F (Ref. SW-0085).

See Section 2.4.11 for the evaluation of the capability of the UHS to provide minimum water requirements considering, non-concurrently, the most severe natural phenomenon, reasonable combinations of less severe phenomena, and the single failure of any man-made structural component. This evaluation includes a discussion or reference to appropriate design details, describes allowable minimum flows and levels, and identifies margins.

As shown in Figure 9.2.1-1, the line from the Auxiliary Reservoir to each emergency service water pump chamber is provided with a normally open valve. The line from the Main Reservoir to each emergency service water pump chamber is provided with a normally closed valve. This valving arrangement together with the Emergency Service Water and Cooling Tower Makeup Intake Structure provides the following:

1) The emergency service water pumps are normally lined up to take suction from the Auxiliary Reservoir under the conditions described in Section 9.2.1. The emergency service water pump suction can be switched to the Main Reservoir from the Auxiliary Reservoir by opening and closing the appropriate valves. Transfer of the suction to the Main Reservoir requires changing the position of two valves. First the valve to the Main Reservoir is opened and then the valve from the Auxiliary Reservoir is closed. The time required to change the position of each of these valves for manual switching between the two UHS sources is approximately four hours. Based upon the wave surge analysis from the complete and instantaneous failure of the Auxiliary Dam (see Section 2.4.4), there is sufficient time to transfer suction to the Main Reservoir without interrupting emergency service water flow.

2) A single failure will not drain excessive water from the Auxiliary Reservoir to the Main Reservoir since the line from the Auxiliary Reservoir can be isolated by a butterfly valve. Levels in the pump bays are monitored to provide indication of system leakage.

The Emergency Service Water and Cooling Tower Makeup Water Intake Structure and Emergency Service Water Screening Structure are both designed to fully meet the requirements of General Design Criterion No. 4 (see Section 3.1) including the dynamic effects of missiles occurring from equipment failures and from tornado generated missiles; see Section 3.5 for a further discussion.

See Section 3.8.4.1.12 for figures which illustrate the plan, front, and section views of the Emergency Service Water and Cooling Tower Makeup Intake Structure and Emergency Service Water Screening Structure. As shown in the figures, equipment in these structures is placed in individual bays and is separated by concrete walls. This arrangement will preclude damage to more than one redundant service water system train in the event of mechanical failure of a rotating piece of equipment.

The emergency service water pump motors and associated equipment are protected against tornado missile or other missile damage by protective structures. These protective structures are designed to preclude the unlikely possibility of the pump motors flooding. The essential services water system equipment is also protected against failure of non-Seismic Category I equipment.

9.2.5.4 Tests and Inspections

The water control structures of the ultimate heat sink will be inspected based on the guideline of Regulatory Guide 1.127. Section 1.8 contains the SHNPP position on this regulatory guide.

Preoperational testing of the Service Water System, as described in Section 14.2.12, will also verify the flow capability of the ultimate heat sink.

The Technical Specifications contain the periodic testing requirements and limiting conditions for operation of the ultimate heat sink.

9.2.5.5 Instrumentation Applications

Level transmitters located in the emergency service water bays monitor levels in the bays. These level transmitters provide indication of system leakage by means of alarms at minimum water level in the Auxiliary and/or Main Reservoirs.

An alarm for low water level in the Auxiliary Reservoir is also provided for the initiation of the switchover of the emergency service water pump suction from the Auxiliary Reservoir to the Main Reservoir.

The position of the valves located in the lines from the Auxiliary and Main Reservoirs are indicated in the Control Room. In addition, alarms are provided to alert the operator if these valves are not in the correct position.

Differential water level alarm will be provided in the Main Control Room when a high-high differential head of water is reached.

9.2.6 CONDENSATE STORAGE FACILITIES

9.2.6.1 Design Bases

The condensate storage tank (CST) is designed to:

a) Provide makeup and surge capacity for secondary system inventory changes due to various plant conditions.

b) Provide sufficient water storage for reactor shutdown decay heat removal by the Auxiliary Feedwater System. (This function is described in Section 10.4.9).

c) Provide flush water for radwaste treatment equipment.

9.2.6.2 System Description

The Condensate Storage System is shown schematically on Figure 10.1.0-4. The Condensate Storage System consists of the following:

a) one 100 percent capacity, condensate transfer pump

b) one 415,000 gallon stainless steel tank

c) piping, valves and instrumentation.

Condensate Storage Tank (CST) makeup is normally provided from the Demineralized Water System (refer to Section 9.2.3). Capability also exists to provide makeup from the Liquid Waste Management System (refer to Section 11.2).

The stainless steel material used for the construction of the CST is compatible with the water chemistry of both the Demineralized Water System and the Condensate System. The materials of the remainder of the system's equipment and components are such that the water quality required by the various receivers is achievable.

The condensate transfer pump discharges into the condenser hotwell. This operating mode is primarily used for initial fill of the Condensate System and subsequent makeup, if required. During normal plant operation, condensate flows by gravity and atmospheric pressure from the CST to the condenser hotwell. Condensate hotwell high-level dumping is done either from the condensate pump discharge to the CST or from the condensate booster pump discharge to the CST. The water level in the hotwell is maintained automatically by two level control valves. A recirculation line from the condensate transfer pump to the CST is provided to ensure that the minimum safe flow through the pump is maintained during pump operation.

Design data for the condensate storage tank and transfer pump are given in Table 9.2.6-1.

The overflow from the CST is monitored for radiation before being discharged to the environment. If radioactive contamination is detected in the overflow, it is pumped to the floor drain tank for processing in the waste processing system. If it is not radioactively contaminated it is discharged to the environment (see Section 9.3.3).

9.2.6.3 Safety Evaluation

The CST below the elevation of the condensate transfer pump suction nozzle and the supply piping between the tank and the auxiliary feed pumps are classified Safety Class 3 and Seismic Category I. A concrete enclosure protects the tank from tornado, hurricane and missile damage. This enclosure will also provide protection from high and moderate energy pipe breaks.

The Harris licensing basis dictates that in the event of a LOOP, sufficient CST useable inventory must be available to bring the plant from full power to hot standby conditions, maintain the plant at hot standby conditions for 6 hours and then cooldown the reactor coolant system to a residual heat removal at a conservatively reduced cut-in temperature of 325°F in six hours. The CST analysis-of-record is based on the following assumptions; a power level of 2958 MWt, a CST fluid temperature of 120°F, and a no-load steam generator secondary side level of 50% narrow range span at the end of cooldown. The storage requirement for the LOOP event is a usable inventory of less than 212,000 gallons.

The minimum safety related useable inventory is about 238,000 gallons. A CST water level of 26.8 ft. incorporates the minimum required usable volume plus unusable volume due to tank physical characteristics and pump suction vortex suppression plus margin. A minimum water level in the CST of 26.8 ft equates to a contained volume (usable plus unusable) of 250,635 gallons.

The minimum contained volume of water in the CST as defined in TS is 270,000 gallons or 62% indicated level. The basis for this TS minimum volume includes the analysis of record for minimum required volume plus an allowance for water not usable plus instrument uncertainties plus engineering design margin.

The locations for all connections to the CST are indicated in Figure 9.2.6-1. To ensure that the minimum condensate storage tank inventory required for the operation of the Auxiliary Feedwater System is preserved, all non-seismic piping connections (1,2,3,4,6,7 and 18) are located above the minimum water level required for auxiliary feedwater supply. Piping connections to nozzles 5 and 8 are designed to seismic Category I criteria. Based on the above, any failure of a non-seismic pipe due to an SSE will not jeopardize the dedicated volume for the AFW system.

The level transmitters for the CST are designed to Seismic Category I and are located on elevation 236' of the Tank Building. Failure of non-seismic piping will not cause failure of the CST level transmitters, and water will remain contained within the Seismic Category I structure.

The concrete enclosure of the CST will minimize the possibility of freezing in the tank during extreme cold weather conditions. In addition the system has the capability of recirculating warm water (approximately 125 F) from the condenser hot well, to maintain the water temperature in the tank above the freezing point. This recirculation mode can be accomplished by opening the by-pass valve of the hot well makeup level control valve which will provide continuous recirculation between the hot well and the CST.

The condensate storage facility is not a principal source of radionuclide release. The potential sources of contamination are the water dumped in the CST from the secondary waste sample tank and from the Condensate System. Dumping of secondary waste sample tank water is administratively controlled to preclude condensate contamination. The Condensate System is normally expected to be free of radioactivity. However, primary to secondary leakage in the steam generator tubes is a potential source of condensate contamination. Expected source terms for the Secondary System are given in Section 11.1. The radiological consequences associated with failure of the CST are discussed in Section 2.4.12.

Protection of safety related systems, structures and components, which includes the condensate storage facility from the effects of natural and accidental phenomena are discussed in the following Sections:

Tornado Wind	Section 3.3.2
Hurricane Wind	Section 3.3.1
Flooding	Section 3.4.1
External and Internal Missiles	Section 3.5
Protection Against Dynamic Effects Associated with the Postulated Rupture of Piping	Section 3.6

9.2.6.4 Testing and Inspection

Components are inspected and cleaned prior to installation. The system initially will be operated and tested to assure its proper operation, instruments will be calibrated, and automatic controls will be tested for actuation at the proper setpoints.

The Condensate Storage System will be tested in accordance with the procedure outlined in Section 14.2.12 and the Technical Specifications. Safety related portions of this system will be inspected in accordance with Section 6.6.

9.2.6.5 Instrumentation Application

Water is added to the tank by using a control valve in the CST makeup line. Safety related CST water level indicators and CST level alarms are provided in the Control Room. A Hi-Hi level alarm is provided to prevent overfilling. A low and minimum level alarm is provided to alert the operator to the status of the CST shutdown water inventory. An empty alarm is provided to alert the operator that the CST water inventory is nearing depletion and allows him 20 minutes to align the system to the alternate water supply (ESW).

Two (2) redundant safety grade level transmitters (LT-1CE-9010A-SA, LT-1CE-9010B-SB) are provided on the CST for tank inventory monitoring. There are two separate tank taps and tubing for transmitter monitoring. Both level transmitters provide a signal via train A and train B to separate safety grade level indicators. The redundant level indicators provide indication to operators at the MCB and ACP of CST water inventory. Also each level transmitter provides a signal to redundant CPU's. Each CPU, on a separate train has alarm and indication of tank water inventory.

Also, the level transmitter for train B provides a signal to six (6) level switches which in turn provide the following control functions:

a) One High Level - Controls tank make-up, no alarm.

b) One Low Level - Controls tank make-up, no alarm.

c) One High-High - Tank overflow, alarm.

d) One Low-Low - Indicates minimum level to meet Technical Specification quantity of water to meet accident requirements, alarm.

e) One Low-Min - Indicates approach to minimum water level for accident, alarm.

f) One Empty - Indicates approach to water depletion, and allows operator twenty (20) minutes to switch to alternate water supply, alarm.

The level switches provide four (4) alarms and indication on the MCB and ACP. System will fail in the alarm mode.

A CST sample line is routed to a sink on 236 'el. Tank Area Building. The following parameters are analyzed using inline instrumentation:

a) Oxygen

b) pH

c) Cation conductivity

d) Total conductivity

Any parameter out of specification will alarm in the secondary sample room and the main control room.

Details of the condensate storage tank are shown on FSAR Figures 9.2.6-1 and 10.1.0-4.

9.2.7 BOP INTERFACE

This section is not applicable to the Shearon Harris Nuclear Power Plant.

9.2.8 ESSENTIAL SERVICES CHILLED WATER SYSTEM

The objective of the Essential Services Chilled Water System (ESCWS) is to provide chilled water to the cooling coils of air handling units for the following systems:

a) Control Room Air Conditioning System. Refer to Section 9.4.1 for a detailed discussion.

b) Reactor Auxiliary Building NNS-Ventilation Systems. Refer to Section 9.4.3 for a detailed discussion.

c) Reactor Auxiliary Building ESF Equipment Cooling System. Refer to Section 9.4.5 for a detailed discussion.

d) Reactor Auxiliary Building Switchgear Rooms Ventilation System. Refer to Section 9.4.5 for a detailed discussion.

e) Reactor Auxiliary Building Electrical Equipment Protection Rooms Ventilation System. Refer to Section 9.4.5 for a detailed discussion.

f) Fuel Handling Building Spent Fuel Pool Pump Room Ventilation System. Refer to Section 9.4.2 for a detailed discussion.

9.2.8.1 Design Bases

The Essential Service Chilled Water System is designed to meet the following design bases:

a) The system supplies a nominal 44 F chilled water to the cooling coils in the air handling units.

b) The system is designed with sufficient redundancy to meet the single failure criteria.

c) The system is designed to meet Safety Class 3 and Seismic Category I requirements.

d) The system is designed to provide accessibility for adjustments and periodic inspections and testing of the principal system components.

9.2.8.2 System Description

The Essential Services Chilled Water System is shown on Figures 9.2.8-1, 9.2.8-2, and 9.2.8-3. It consists of two 100 percent capacity subsystems A and B (one operating-one standby). Design data for principal system components are presented in Table 9.2.8-1.

Each subsystem consists of a package water chiller, an expansion tank, a makeup water system, a makeup tank, a chemical addition tank, a chilled water pump and an independent piping system. The condenser section of the water chiller will be supplied with cooling water from the Service Water System during normal and emergency plant operation. Refer to Section 9.2.1 for a detailed discussion of the Service Water System.

The expansion tank, located on 324' FHB accommodates system volume changes, maintains positive pressure in the piping loop and provides a means for adding makeup water to the system. Makeup water to the system is fed from the Demineralized Water System during normal operation; during post-accident conditions, the makeup water is fed from the Service Water System. The water level in the tank is automatically maintained by a level switch. A chemical addition tank located in the system provides the necessary chemicals to prevent corrosion and scale buildup in the system. Chemical addition is manual when it is required by periodic water analysis tests. The makeup tank originally served as a pressurized expansion tank but was later converted to a water-solid tank off of the normal makeup water flow path when atmospheric expansion tanks were installed on 324' FHB. The makeup tank no longer has any specific function other than to serve as part of the ESCW pressure boundary.

9.2.8.2.1 Chilled water piping distribution

The chilled water piping distribution is arranged as follows:

1) The chilled water supply to the spent fuel pool pump room air handling units in the Fuel Handling Building is provided from the Essential Services Chilled Water System.

2) All air handling units serving the reactor auxiliary building switchgear rooms are provided with redundant 100 percent capacity cooling coils piped independently to two subsystems. The coils are piped on opposite sides of the air handling unit so that piping is completely separated.

3) The chilled water cooling coils in the air handling units serving the Reactor Auxiliary Building NNS-Ventilation Systems are supplied from subsystem A or B. The non-nuclear safety piping connections at the main headers of each subsystem are provided with fail closed isolation valves which will automatically isolate the non-safety related portions of the system during accident conditions.

4) All chilled water cooling coils in the fan-coil units serving the reactor auxiliary building ESF equipment are independently supplied from their corresponding chilled water subsystems A and B.

9.2.8.2.2 Chilled water cooling coils flow control

The chilled water flow rates for various operating modes of each air handling unit in the chilled water subsystems are tabulated on Figure 9.2.8-2.

The chilled water cooling coils flow control diagrams for various systems are also shown on Figure 9.2.8-2.

9.2.8.3 Safety Evaluation

The Essential Services Chilled Water System is a safety related system and is designed to Safety Class 3, Seismic Category I requirements. Non-essential portions of the Essential Services Chilled Water System are automatically isolated from the essential portions upon receipt of an SIAS, or are separated by check valves.

The essential services chilled water system will not be adversely affected by either pipe rupture events or internally generated missiles. Internal missiles generated by the potential sources identified in Sections 3.5.1.1 and 3.5.1.2 are either not credible or do not adversely affect safety-related equipment in the plant areas where the ESCWS is located.

Each subsystem is physically separated from the other subsystems, to assure that the system is capable of meeting the single-failure criteria. Refer to Table 9.2.8-2 for a single-failure analysis of the Essential Services Chilled Water System.

Figure 9.2.8-2 indicates the maximum refrigeration load on the ESCWS for the various modes of operations. The design capacity of the ESCWS is adequate for the expected maximum refrigeration loads.

In the event of a failure in a single train of the ESCWS during an accident, a redundant 100% capacity system would still be available. System redundancy is clearly shown on Figure 9.2.8-1 and the ESCWS design capacity is given in Table 9.2.8-1.

Upon receipt of SIAS, the Demineralized water supply will be isolated using redundant solenoid operated valves arranged in series. The supply will then be provided from the Service Water

System. The source of water supply to the condenser section of the ESCWS is from the Service Water System during normal and emergency plant conditions.

Although the solenoid valves used to isolate the ESCW system from the Demineralized water supply are designed to close upon receipt of a SIAS, they are no longer credited for closure in order to maintain ESCW inventory or pressure. These valves serve to provide additional protection against the unlikely failure of a non-safety demineralized water regulating valve during emergency conditions. Such a failure would not challenge the ESCW pressure integrity, but could create an undesirable operator distraction which the presence of the solenoid valves eliminates.

In the event of loss of offsite power, all active components such as valve operators, water chiller motors, chilled water pumps, controls and instrumentation will be supplied with power from the emergency diesel generators. Each subsystem will be powered from a different emergency bus.

9.2.8.4 Inspection and Testing Requirements

The design of the ESCWS permits functional and pressure testing of the system during normal plant operation. Pressure testing of the ESCWS can be accomplished by supplying pressure at any convenient valved outlet such as pump inlet or discharge piping, etc. shown on Figure 9.2.8 3. Pressure readings can also be taken at those points.

ESCWS is also equipped, at the main chilled water supply source, with orifice type measuring devices which will confirm that the required flow is maintainable. A typical device appears on Figure 9.2.8-3.

In addition, each cooling coil circuit is equipped with a flow measuring device which will be used to assure that flows to each coil are adjusted and balanced to meet minimum flow requirements as tabulated in Figure 9.2.8-2.

The nuclear safety related portions of the ESCWS fall under the requirements of Section 6.6 for inservice inspection. Pump and valve testing is described in Section 3.9.6. Preoperational and start-up test requirements are found in Section 14.2.12. Periodic test requirements are found in the Technical Specifications.

9.2.8.5 Instrumentation Requirements

The instrumentation and controls for the Essential Services Chilled Water System are designed for automatic operation after manual starting of the pumps and water chillers.

The automatic controls are arranged to prevent an accidental startup of water chillers without first establishing the flow of chilled water in the system. After the initial manual startup, each chiller is under the control of its own internal automatic control system to maintain the required chilled water outlet temperature. The chilled water pump is monitored for flow failure with a chiller trip on low chilled water flow. A differential pressure flow switch in the chilled water evaporator is provided to alarm a low flow condition on the Control Room panel. The operator may manually start the standby system from the Control Room. Condenser low flow as well as high and low refrigerant pressure are annunciated and alarmed in the control room. Similarly high evaporator flow is annunciated and alarmed while evaporator low flow and low temperature

produce chiller trips in addition to the trouble annunciation and alarm. Individual alarm annunciators are provided on the MCB for Compressor High Oil Temperature, Compressor High High Discharge Temperature, Compressor Refrigerant Low Pressure and Compressor Refrigerant High Pressure.

Makeup water level in the essential services chilled water system expansion tank is automatically controlled. Abnormally high and low water levels are annunciated in the Control Room. An Essential Services Chiller in standby is started and run to reduce evaporator pressure should this pressure reach the high pressure alarm setpoint. This is to ensure reliable chiller startup per EC 82036.

Refer to Chapter 7 for a detailed discussion of the instrumentation and controls for the ESCWS.

9.2.9 NON-ESSENTIAL SERVICES CHILLED WATER SYSTEM

The objective of the Non-Essential Service Chilled Water System (NESCWS) is to provide chilled water to the cooling coils of air handling units for the following systems:

a) Fuel Handling Building Air Conditioning System for spent fuel pools and operating floor area. Refer to Section 9.4.2 for a detailed discussion.

b) Waste Processing Building HVAC System. Refer to Section 9.4.3 for a detailed discussion.

9.2.9.1 Design Bases

The Non-Essential Service Chilled Water System is designed to meeting the following design bases:

a) The system supplies a nominal 44°F chilled water to the cooling coils in the air handling units. In addition, chilled water is supplied to provide additional cooling of the WPBCCW supply to the WG Compressors and Recombiners (WG Precooler).

b) The arrangement of two chillers in series provides an economical design with reference to power consumption and simple installation of piping, electrical wiring and control.

c) The system is designed to provide accessibility for adjustment and periodic inspections and testing of the principal system components.

9.2.9.2 System Design

The Non-Essential Services Chilled Water System is shown on Figures 9.2.9-1 and 9.2.9-2. System component design data are presented in Table 9.2.9-1.

The system consists of two 50 percent package water chillers with condenser waterflow in series and chilled water in counter flow series, an expansion tank, a chemical addition tank, two chilled water pumps (one operating and one stand-by) and a piping system. The cooling water for the condenser section of the chillers is supplied from the Service Water System.

The expansion tank is piped to the suction side of the non-essential services chilled water pumps and provides positive suction head, accommodates system volume changes and provides means for adding makeup water to the system. Makeup water to the expansion tank is fed from the Fire Protection System. The water level in the tank is automatically maintained by a level switch. A chemical addition tank is provided to prevent corrosion and scale buildup in the system. Chemical addition is manual when it is required by periodic water analysis test. The two chilled water pumps are arranged in parallel (one operating and one stand-by) with isolation valves provided. The chilled water piping distribution flow diagram is shown on Figure 9.2.9-2. Air handling units with cooling coils serving the Waste Processing Building and Fuel Handling Building operating floor and the WG Precooler are supplied from the Non-Nuclear Safety Chilled Water System. The chilled water flow rates for each air handling unit and WG Precooler in the Non-Essential Services Chilled Water System are shown on Figure 9.2.9-2.

The chillers are equipped with an Automatic Capacity Control System that enables start-up and shutdown of one of the chillers due to seasonal load variations.

Chiller capacity can be reduced to 10 percent. In addition to the capacity control system, each chiller is provided with automatic stop of the compressor if cooling load falls below 10 percent and for automatic restart.

9.2.9.3 Safety Evaluation

The Non-Essential Services Chilled Water System is not safety related. The system is not required to operate during accident conditions. Upon a loss of power, the Non-Essential Services Chilled Water System is shutdown. The functioning of safety-related systems or components is not adversely affected by a postulated failure of any portion of the moderate energy non-essential services chilled water system. Refer to FSAR Section 3.6.1 for details on the analysis of dynamic and environmental effects of pipe ruptures, and to FSAR Appendix 3.6A for details on the flooding analysis.

9.2.9.4 Inspection and Testing

Preoperational and periodic test and inspections of important system functions are performed. Flow measuring devices, thermometers and pressure gauges are provided at selected points in the Non-Essential Services Chilled Water System to verify the acceptable flows, temperatures and pressures.

Where appropriate, major components are inspected and cleaned prior to installation into the system. Preoperational testing includes calibrating instruments, checking the operability and limits of alarm functions, and setting of safety valves.

9.2.9.5 Instrumentation

Description of the instrumentation is given in Chapter 7.

9.2.10 WASTE PROCESSING BUILDING COOLING WATER SYSTEM

The Waste Processing Building Cooling Water System (WPBCWS) provides cooling water to various plant components located in the Waste Processing Building (WPB) during all phases of

plant operation and shutdown, and serves as an intermediate system between the Waste Processing System (WPS) and the Service Water System (SWS).

9.2.10.1 Design Basis

The WPBCWS is designed to operate during all phases of normal plant operation including startup, power operation, shutdown and refueling.

The design of the WPBCWS is based on a maximum service water supply temperature of 95 F.

The WPBCWS is designed to supply cooling water at a maximum temperature of 105 F to the components being cooled.

9.2.10.2 System Description and Operation

The WPBCWS is shown on Figures 9.2.10-1 and 9.2.10-2. Design parameters for the WPBCWS are given in Table 9.2.10-1.

The WPBCWS serves as an intermediate system between the WPS and SWS to ensure that leakage of radioactive fluid from components being cooled is contained within the plant. During operation of the WPBCWS the SWS will be in operation and will be at a higher pressure than the WPBCWS.

The WPBCWS consists of two WPB cooling water heat exchangers, two WPB cooling water pumps, a WPB cooling water surge tank, cooling lines to the various components being cooled, and associated piping, valves and instrumentation. The coolant flows from the pumps, through the components being cooled, through the shell side of the WPB cooling water heat exchangers, and back to the pumps.

The surge tank is connected to the suction side of the WPB cooling water pumps. It accommodates surges resulting from coolant thermal expansion and contraction and accommodates water which may leak into the system from components which are being cooled. The surge tank also contains a supply of water to provide cooling water supply until a leaking cooling line can be isolated. The surge tank water level is maintained manually by the surge tank level control valve bypass valve located in the makeup water supply from the Demineralized Water System.

Water chemistry control of the WPBCWS is accomplished by additions to the chemical addition tank or to the WPB cooling water surge tank. Corrosion coupons or grab samples can be analyzed to monitor the effectiveness of the corrosion inhibitor. Periodic grab samples will be analyzed by Chemistry to ensure adequate protection is being provided to maintain the integrity of the system. Corrosion will be minimized through control of impurities and chemical additives. Adjustments will be made based upon results obtained from the analyses.

The flow requirements for the various WPBCWS cooling loads are given in Table 9.2.10-3.

9.2.10.2.1 Equipment Served by the WPBCWS

The WPBCWS provides for the following heat sources:

a) Waste Gas Compressors

b) Catalytic Recombiners

c) Waste Evaporators

d) Reverse Osmosis Concentrate Evaporators

e) Reverse Osmosis Module Precoolers

f) Reverse Osmosis Module Chillers

g) Volume Reduction Condensers

h) Waste Evaporator Concentrate Tank Vent Gas Condensers

i) Secondary Waste Evaporators

j) Radiation Monitors

9.2.10.2.2 Component Description

The codes and standards, to which the individual components of the WPBCWS are designed, are selected according to the most severe condition expected for each component during all phases of plant operation. Codes and standards applicable to the WPBCWS are listed in Table 3.2.1-1.

WPB Cooling Water Heat Exchangers

The WPB cooling water heat exchangers are shell and straight tube type units. Waste processing cooling water circulates through the shell side. The service water stream, which may foul the heat transfer surfaces, is passed through the tubes. The tube side is designed for easy cleaning. The shell is constructed of carbon steel and the tubes are made of 90-10 copper nickel alloy.

During normal operation the SW pressure on the tube side is higher than the WPBCWS pressure and any failure of the tubes would result in leakage of SW into the WPBCWS.

The heat removal load during normal full-power operation is accommodated by one WPB cooling water heat exchanger with the additional exchanger providing 100 percent standby capacity. The provisions of two 100 percent capacity WPB cooling water heat exchangers provides redundancy thereby ensuring that heat removal capacity will not be lost if one exchanger fails or becomes inoperative, and permits maintenance or replacement of one exchanger while the other unit is in service.

WPB Cooling Water Pumps

Two 100 percent capacity pumps are provided. Each WPB cooling water pump is a horizontal, centrifugal unit with carbon steel casings, internals, and shafts.

WPB Cooling Water Surge Tank

The WPB cooling water surge tank is cylindrical, horizontal and is made of carbon steel.

The surge tank capacity permits:

a) The surge tank to accommodate changes in WPBCWS water volume due to changes in operating temperature.

b) The normal water volume in the tank to provide an immediate source of makeup if a leak develops in the WPBCWS.

The surge tank is located at an elevation that ensures adequate net positive suction head to the WPB cooling water pumps. The surge tank is normally open to the atmosphere, but if high radiation is detected in the discharge line of the WPB cooling water pump, the surge tank vent line is automatically closed. When the vent valve is closed, the surge tank is protected from overpressurization by a spring loaded safety valve, and from collapsing by a vacuum breaker. The safety valve relief is discharged to the component cooling water holdup tank.

Waste Processing Cooling Water System Piping

Carbon steel is used for piping since it has good corrosion resistance when in contact with the chemically controlled cooling water. All piping joints and connections are welded. Flanged connections are used at pumps, heat exchangers, valves and instrumentation connections, to facilitate removal for maintenance.

The piping of the WPB Cooling Water System does not require thermal insulation since it rarely reaches a temperature higher than 150 F.

Waste Processing Cooling Water System Valves

All WPBCWS valve bodies except butterfly valves and relief valves are welded carbon steel with stellite or stainless steel trim. Relief valves are positioned downstream of components to relieve the volumetric expansion which occurs if the WPB cooling water lines to the component are isolated and the water temperature rises.

9.2.10.2.3 System Operation

Normal Operation

Only one WPB cooling water heat exchanger and one pump are required for operation. One pump is placed on standby to start automatically on low pressure in the pump discharge header.

Periodically, a sample of the WPB cooling water is taken by the plant operator to ascertain that water chemistry specifications are met. Chemicals are then added and mixed by recirculation as necessary.

The component cooling water hold-up tank has a capacity of 10,000 gallons and is located in the fuel handling building on elevation 216. The CCW holdup tank collects water from the component cooling water drain tank, the WPB cooling water sump and the WPB component

cooling water surge tank. The water in the CCW holdup tank is then mixed and sampled. Depending on chemical and radiochemical analysis, the water can then be transferred to the floor drain system for processing, to the waste neutralization system via the secondary waste system, to a vendor for offsite disposal or be reused in the component cooling water system.

9.2.10.3 Safety Evaluation

The WPBCWS is not a nuclear safety class or Seismic Category I system. This system is not considered available during accident and emergency condition and no credit is taken in the safety evaluation.

Leakage into or out of the WPBCWS from any component being served by the system is detected as an increase or decrease of water level in the surge tank. Leakage into the WPBCWS may also be detected by an increase in system radiation level. Details of the radiation monitoring equipment are given in Section 11.5.

9.2.10.4 Tests and Inspections

Preoperational testing is described in Chapter 14. The performance and structural and leaktight integrity of all WPBCWS components is demonstrated by continuous operation.

9.2.10.5 Instrumentation Requirements

The WPBCWS instrumentation provides the required signals for safe, reliable, and efficient operation and control of the system. The operation of the WPBCWS is monitored with the following instrumentation:

a) Temperature sensor and local temperature indicators upstream of the shell and tube sides of the WPB cooling water heat exchangers.

b) Temperature sensor and local temperature indicators in the tube side outlet lines of the WPB cooling water heat exchangers.

c) Local temperature indicators in the shell side outlet lines of the WPB cooling water heat exchangers.

d) Pressure switches, indicators and test connections upstream of the WPB cooling pumps.

e) Pressure indicators and transmitters downstream of the WPB cooling water pumps.

f) Temperature element on common discharge line of WPB cooling water pumps.

g) A remote indicator to measure flow downstream of the WPB cooling water pumps located on the Waste Processing Control Board (WPCB).

h) Pressure indicator on the common service water line to the tube side of the WPB cooling water heat exchangers.

i) Flow element and transmitter on the inlet service water lines to the tube side of the WPB cooling water heat exchangers.

j) Pressure test connections on the inlet and outlet service water lines to the tube side of the WPB cooling water heat exchangers.

k) Pressure indicator on the service water discharge header from the tube side of the WPB cooling water heat exchangers.

Computer inputs for flow are provided in the cooling water outlet lines from the following equipment items to establish the required coolant flows:

- Waste gas compressors
- Catalytic recombiners
- Reverse osmosis concentrate evaporators
- Reverse osmosis module precooler and chillers
- Waste evaporator package
- Secondary waste evaporators

Local and WPB control room indication of surge tank levels keeps the operator informed of any leakage into or out of the WPBCWS. High and low level signals actuate alarms if the water level in the surge tank is above or below the normal range.

Temperature and flow computer inputs are provided in the WPB cooling water outlet lines from most equipment cooled by the WPBCWS. These instruments monitored by the computer provide means to establish the required coolant flows and to determine the component cooling heat loads. Local temperature indicators and pressure test connections are also provided in the WPB cooling water inlet and outlet lines from most equipment cooled by the WPBCWS.

A radiation detector installed in WPB cooling water heat exchanger shell inlet header closes the surge tank vent on high radiation.

A level site glass provides local level indication in the chemical addition tank. The chemical addition tank bypass line has a temperature element, and a flow element and transmitter which provide input to the computer.

9.3 PROCESS AUXILIARIES*

9.3.1 COMPRESSED AIR SYSTEMS*

9.3.1.1 Design Bases

The Compressed Air System (CAS) consists of two air subsystems, the Instrument Air System and the Service Air System, which are designed to meet the following design bases:

* Further information is contained in the TMI appendix.

a) The Compressed Air System delivers dry, filtered, oil-free compressed air to meet pneumatic instrument and control requirements, as well as for operation of pneumatic tools during maintenance and refueling service.

b) The CAS pressure is maintained within specified limits while delivering sufficient compressed air to supply maximum postulated system demands.

c) Non-safety related pressure containing components of the CAS are designed and constructed in accordance with ASME Boiler and Pressure Vessel Code Section VIII. System piping, with the exception of the containment penetrations and portions of the piping upstream of PORV's 1RC P527SA 1 and 1RC P529SB 1 pneumatic power supplies, is fabricated and installed in accordance with ANSI B31.1.

d) Safety related pressure containing components of the CAS, which include the containment penetrations and safety related valve accumulators and associated piping and valves and portions of the pneumatic piping around nitrogen accumulators 1A SA and 1C SB and up to PORV's 1RC P527SA 1 and 1RC P529SB 1, are designed and constructed in accordance with ASME Boiler and Pressure Vessel Code Section III. However, nitrogen accumulators 1A SA and 1C SB are stamped ASME B&PV Code Section VIII but have been evaluated as meeting the criteria of ASME B&PV Code Section III. The system boundary check valves for these accumulators are not ASME Section III. These valves are procured as Commercial Grade Items and are dedicated per Code (CFR) requirements for safety related use. All containment piping penetrations meet the intent of GDC 54 and 56.

e) The CAS meets all NSSS Vendor interface requirements.

9.3.1.2 System Description

The CAS is shown on Figures 9.3.1-1, 9.3.1-2, and 9.3.1-3 and the equipment design parameters are given in Table 9.3.1-1. The nitrogen and Instrument air systems supply accumulators 1A-SA and 1C-SB and 1B-NNS for the pressurizer PORV. The flow diagrams for this piping are shown on Figure 6.3.2-02.

The Compressed Air System consists of the following:

a) one 100% CAS capacity non-lubricated, three-stage Centrifugal compressor

b) two 50% CAS capacity non-lubricated, two-stage rotary air compressors

c) two vertical instrument air receivers

d) one 100% CAS capacity air dryer with pre- and after-filters

e) two 50% CAS capacity air dryers with pre- and after-filters

f) two vertical service air receivers

g) two vertical personnel breathing air receivers

h) piping, valves and instrumentation

i) air accumulators, on particular air operated valves

j) necessary connections for a temporary air compressor.

The main system components (compressors, intercoolers, aftercoolers, dryers, receivers and local control panel) are located in the outdoor portion of the Turbine Building. The intake filter/silencers are thereby located to allow an outside air suction.

The Compressed Air System (CAS) maintains system pressure within the operating range given in Table 9.3.1-1.

The CAS is sized to provide the air required for normal operation of the IA or SA system including simultaneous operation of all pneumatic devices required for a normal shutdown of the plant.

Air Compressors 1A, 1B, and 1C are air cooled and do not require service water cooling. Separately mounted pipeline aftercoolers utilize the Service Water System (Section 9.2.2.2) for cooling to reduce air temperature to Air Dryers 1A, 1B, and 1C. Each Air Compressor has its own skid mounted filter-silencer, intercooler and aftercooler. The air outlets of Air Compressors 1A, 1B, and 1C are piped to the water cooled aftercoolers, desiccant air dryers with prefilter and afterfilter, and finally to the breathing air receivers, instrument air receivers and service air receivers.

Compressed air from the instrument air receivers and service air receivers is passed through a prefilter, an air dryer, and an afterfilter. One chamber per dryer is always regenerating while the other chamber is in service.

Compressed air from the service air receivers supplies the service air requirements. A control valve located in the common header provides for automatic isolation of the service air subsystem in the event of decreased service air receiver pressure, thereby preserving instrument air pressure.

The design connections for the air compressors enable any of the three compressors to be used to supply either, the IA or SA systems.

Instrument and service air ring headers and branch lines supply the compressed air requirements of the Containment Building, Fuel Handling Building, Water Treatment Building, Reactor Auxiliary Building, Turbine Building, Waste Processing Building, and various yard facilities. Service air connections are provided for the Service Building, the Diesel Generator Building, and various yard facilities.

Relief valves are provided downstream of each air compressor and on each air receiver to protect piping and components against overpressure. The air accumulators, the piping between the accumulators and the air actuated valves, the check valve on the supply line for the accumulator, and the piping that penetrates the Containment with its related isolation valves, are safety related. The flexible hoses and 1" pneumatic piping upstream of PORV's 1RC P527SA-1 and 1RC-P529SB-1, nitrogen accumulators 1A-SA and 1C-SB, and the piping

feeding these accumulators up to and including the nitrogen and instrument air supply check valves are safety related.

The accumulators store compressed air which will be used in actuation of valves which are required to operate during and following an accident, when credit cannot be taken for the availability of the rest of the CAS. Each accumulator and its associated piping is sized to store sufficient compressed air to provide for at least four full strokes of the valve actuator. The safety related function of the nitrogen accumulators 1A-SA and 1C-SB is required for the steam generator tube rupture event only.

In addition to meeting instrument and control pneumatic requirements, the Instrument Air System is designed to provide a source for breathing air. Breathing air outlets are provided at various locations in the Containment Building and the Waste Processing Building. However, areas of the Instrument Air System, inside the RCA, have been radiologically contaminated. Therefore, the breathing air supply is now controlled by plant procedures and is no longer supplied through the Instrument Air System.

9.3.1.3 Safety Evaluation

Operation of the Compressed Air System is not required for the initiation of any engineered safety feature systems, safe shutdown system or any other safety related system, and therefore, the Compressed Air System is not considered a safety related system except for those portions identified in paragraph 9.3.1.1d. The CAS is, however, provided with several features to assure its reliability.

The CAS redundancy is provided by the multiple compressors.

Clean and oil-free instrument air is maintained by the following:

a) Filters at inlet to the compressors

b) Filters at each end of the dryer units

c) Non-lubricated compressors

Air-operated valves not provided with accumulators are designed such that they will fail in their required safe position on loss of instrument air pressure. Those inside the Containment will fail in their required safe position even with a maximum post-accident containment pressure.

Air accumulators are provided on air-operated valves where instrument air is required for operation of the vacuum relief systems, and hydrogen purge systems. Table 9.3.1-2 provides a complete list of safety class valves with accumulators. These valves are not required for operation during the safe shutdown of the plant following an accident except PORV's 1RC-P527SA-1 and 1RC-P529SB-1 which are required for the steam generator tube rupture event. Valves, not provided with accumulators, are designed to fail in their safe position. Shearon Harris' accident analysis does not assume that the instrument air system is operable and does not take credit for the system.

Air-operated isolation valves for nonessential portions of systems which have safety related functions will fail closed upon a loss of instrument air or electrical power.

During and after an accident, the only air-operated valves that require cycling are PORV's 1RC-P527SA-1 and 1RC-P529SB-1 which are available for the steam generator tube rupture event. The accident analyses do not assume that the instrument air system is operable and do not take credit for the system.

Loss of instrument air during normal operation would also cause all air operated valves in the Turbine Gland Sealing System (except the spillover valve) and the turbine drain valves to open. The opening of the turbine gland sealing system valves is annunciated in the Control Room and would result in higher pressures in the Turbine Gland Sealing System. The higher pressure is not considered to be detrimental to the operation of the turbine and a turbine trip would not be required.

Air-operated valves associated with the NSSS (pressurizer relief valves, steam dump system valves and pressurizer spray valves) will fail closed when it is conservative to do so. The power-operated relief valves (PORVs) are pneumatically operated valves via nitrogen supplied from the accumulators with backup instrument air. The accumulators 1A SA and 1C SB and associated piping to their respective PORV's 1RC P527SA 1 and 1RC P529SB 1 are safety related and are required to function for the steam generator tube rupture event. The PORV's are fail closed as designed.

The valve fail-safe position would result in an increase or decrease in Reactor Coolant System heat removal by the secondary system. FSAR Section 15.1 and 15.2 provide analysis of these events with regards to a Condition II event (moderate frequency event).

The worst postulated credible case resulting from a loss of all Instrument Air Systems is a reduction in the pressure relief capacity through loss of the power-operated relief valves, following a complete loss of external load without a direct reactor trip. An analysis of this situation has been carried out to demonstrate the overpressure protection provided in the design of Westinghouse Pressurized Water Reactors. The results of this study have been published in WCAP-7769, "Overpressure Protection for Westinghouse Pressurized Water Reactors" Revision 1. However, it is noted that credit is not taken in the overpressurization analyses for the following power-operated relief valves:

1) Pressurizer power operated relief valves

2) Pressurizer spray valves

3) Steam dump system valves

During post-accident conditions, the sudden loss of instrument air would have no effect on the Safety Injection System and Containment Spray System. These systems are designed such that air-operated valves fail in the preferred position. Valves required to transfer from the injection phase to the recirculation phase are not air-operated valves. Air-operated valves in the Component Cooling Water System and the Service Water System are designed so that on loss of instrument air they fail so as to allow full flow of cooling water through the heat exchangers and equipment required for post-accident operation.

All safety related instrumentation is designed such that complete loss of instrument air during full power operation would in no way reduce the ability of the engineered safety features and

their supporting systems to safely mitigate the consequences of an accident, shutdown the reactor or prevent significant release of radioactivity to the environment.

The air dryers remain connected to the emergency power buses and are manually loaded on to the Emergency Diesel Generators after the automatic load sequencer reaches load block 9, following the automatic loading cycles. When an emergency bus is re-energized, its respective air compressor feeder breaker will close (feeder breaker initially tripped on loss of offsite power).

Service air lines penetrating the containment structure are provided with locked closed manual shutoff valves located outside the Containment, while the instrument air lines have automatically operated isolation valves to seal the containment internal atmosphere from the outside atmosphere during an accident, thereby also isolating the accumulators from the non-safety related part of the CAS.

The operability of components served by the instrument air system fall into the following categories:

a) The instrument air system provides air to air-operated valves which are assumed to fail-safe on loss of instrument air; single failures of such valves are considered in accident analyses. These safety-related valves will be provided with filters immediately upstream of the component. The filter size will be in accordance with manufacturers' recommendations. This filtration will provide protection from particulates which may develop in the supply piping.

   The filters will be subject to surveillance during plant operation and preventive maintenance changeout of the filters in accordance with vendor recommendations and plant experience. Since the devices on the air system do not require high volumes of flow, little if any, filter degradation is expected. If surveillance of the filters indicates degradation surveillance will be expanded. In addition, valves in ASME Code Class 1, 2, and 3 systems would be subject to the quarterly testing requirements of Section XI of the ASME Code and/or response testing in accordance with Appendix J to 10 CFR Part 50. These measures will be adequate to assure the proper functioning of air operated valves.

b) Components which are supplied with accumulators include the pressurizer PORVs, containment hydrogen purge valves, and containment vacuum relief valves, which require a motive force to actuate to a safety function. These valves will be provided with filtration described above.

c) The instrument air system serves many items in the plant whose operability has no direct impact on accident analyses or where, non-random, multiple failures are bounded by accident analysis. These items include components in waste processing systems, water treatment systems, and portions of the main steam, condensate, and feedwater systems which are isolated by the main steam isolation valves or the main feedwater isolation valves.

Missile protection is discussed in Section 3.5. High and moderate energy piping systems and criteria protection against postulated breaks are discussed in Section 3.6.

9.3.1.4 Testing and Inspection Requirements

The Compressed Air System will undergo preoperational and startup tests as described in Section 14.2.12. Periodic tests as required by the Technical Specifications will be performed. Inservice inspections will be performed in accordance with Section 6.6 and the pump and valve testing requirements of Section 3.9.6 will apply.

9.3.1.5 Instrumentation Requirements

The air compressors are designed to function automatically with no operator action required. Either the two 50% CAS capacity compressors or the 1C compressor can supply sufficient capacity for the CAS requirements. Operators will choose the air compressors to supply the CAS flow requirements (1A and 1B versus 1C) at the Compressed Air System Control Panel and the 1C control panel (1C is not connected to the Compressed Air System Control Panel). The running air compressors will run until they trip automatically or are manually stopped. Each air compressor has controls, indications and alarms that are all on the unit. Should an air compressor trip, an alarm will be illuminated in the Control Room complex. Both instrument and service air receiver pressure readouts are provided in the Main Control Room. Low header pressure annunciates in the Main Control Room complex for both IA and SA.

Pressure-reducing valves are provided as required for each air user. Pressure transmitters, pressure switches, and indicating lights provide control room indication of the system condition.

9.3.2 PROCESS SAMPLING SYSTEM

Process sampling is accomplished by a Primary Sampling System (PSS), a Secondary Sampling System (SSS), and a Post-Accident Sampling System (PASS).

9.3.2.1 Design Basis

The PSS is designed to collect fluid and gaseous samples contained in the Reactor Coolant System and Safety Injection System. It is also designed to collect fluid samples from the Boron Thermal Regeneration System, Boron Recycle System, Chemical and Volume Control System, Steam Generator Blowdown System, residual heat removal heat exchangers, and a gas sample from the volume control tank and main steam. The PSS is located in two sampling rooms in the Reactor Auxiliary Building. The sampling points are located in the nearest sampling room. The samples are collected during all modes of operation from full power to cold shutdown without requiring access to the Containment.

The SSS is designed to collect grab samples and continuously analyze samples from the condensate pump discharge, condensate polisher effluent, heater drain pumps, feedwater, steam generator blowdown, main steam, and SG blowdown demineralizers. Most of the SSS is located in an enclosure at the 240 ft. elevation of the Turbine Building. Additionally, the feedwater dissolved oxygen and corrosion product monitors are located in the Turbine Building at the 261 ft. elevation near columns Af and 42.

All high temperature and high pressure liquid samples are cooled by heat exchangers and their pressure reduced by pressure reducing valves.

The samples from the Reactor Coolant System hot leg are designed to pass through enough piping and tubing to permit sufficient decay of nitrogen - 16. The fluid velocity in the sample lines is designed to obtain representative samples. A design flow rate of 0.63 gpm has been assumed for both the liquid purge and sample for the reactor coolant hot leg samples. The gross failed fuel detector and the primary sampling system share a common reactor coolant loop sample path inside containment and parallel outside containment.

Provisions were made to sample the bulk volume of tanks and avoid sampling from low points or potential sediment traps.

The PASS is designed according to the criteria set forth in NUREG-0660 and NUREG-0737 Item II.B.3 to sample reactor coolant during post-accident conditions. The analysis and sampling guidelines of Reg. Guide 1.97, Revision 2, have been followed.

The PASS is designed to continuously accept and analyze a representative Reactor Coolant Sample from either the Reactor Coolant Hot Leg or the Reactor Containment Sump.

The PASS provides for continuous measuring and recording of dissolved oxygen, pH, degassed liquid flow rate, stripped gas flow rate, and hydrogen content of stripped gas.

The PASS also has provisions for taking an undiluted and diluted liquid grab sample and a diluted gas grab sample. The PASS uses no equipment with high pressure carrier gas.

The dissolved oxygen analyzer read out along with the analysis for chlorides in the grab sample will be used to assess if conditions corrosive to stainless steel exist.

The control panel and grab sample equipment of the PASS are located in the Reactor Auxiliary Building, Elevation 236 ft. in an area which is accessible in post-accident situations and which is provided with sufficient shielding to assure compliance with radiation dose rate criteria. Shielding around the grab sample equipment consists of one foot of concrete. The non-shielding outer walls are one foot thick block walls.

The gas separation and sample preparation skids are located in an area on elevation 236 ft. of the RAB which will be inaccessible post-accident. The valves located on these skids will, therefore, be environmentally qualified for the conditions in which they must operate. Shielding around these skids consists of 2 1/2 feet of concrete. The maximum dose a person can receive while in the area and carrying the sample (in a shielded cart) to the chemistry laboratory is less than 1 Rem.

The analysis panel is located in a separate cubicle on elevation 236 ft. of the RAB which is inaccessible post-accident. The analysis panel, however, has provisions for flushing with demineralized water. After flushing with demineralized water, the analysis panels will be accessible for service. Shielding around the analysis panel will consist of 2 ft. of concrete.

The information obtained from the PASS will help to assess and control the course of an accident by providing information on core damage, coolant chemistry and fission products released to containment which may be released to the environment.

The PASS will receive electrical power for a non-safety-related electrical bus powered from on-site sources that will be available post-accident.

9.3.2.2 System Description

Figures 9.3.2-1, 9.3.2-2, and 9.3.2-3 show the flow diagrams for the PSS, SSS, and PASS respectively.

Provisions are made to assure that representative samples are obtained from well mixed streams or volumes of effluent by the selection of proper sampling equipment and location of sampling points as well as the proper sampling procedures.

Sample lines are flushed for a sufficient period of time prior to sample extraction in order to remove sediment deposits and air gas pockets.

The throttling valves in the sampling system have a limited flow coefficient (Cv) range. This range is based on the flow required and the differential head available under operating conditions. This limits the sample flow rate to the required value and prevents excessively high flow.

The daily flow rate to the sample sinks from the various sources in Figure 9.3.2-1 will be dictated by operating procedures and will vary according to start-up, shutdown, and normal operating conditions.

The PSS, SSS, and PASS are constructed of 316SS.

9.3.2.2.1 Primary Sampling System

The PSS provides samples in the two sampling rooms in the Reactor Auxiliary Building, as listed in Table 9.3.2-1 and brings them to a common location in the sampling rooms 1A and 1B PSS panels in the Reactor Auxiliary Building for analysis by the plant operating staff. The analysis performed on the samples determines fission and corrosion product activity levels, boron concentration, lithium, pH and conductivity levels, radiation levels, crud concentration, dissolved gas concentration and chloride concentration, and gas compositions in various tanks.

The results of the analysis are used to regulate boron concentration, monitor fuel rod and steam generator tube integrity, specify chemical additions to the various systems and maintain proper hydrogen and nitrogen overpressure in the volume control tank.

Table 9.3.2-1 includes the pressure and temperature for each primary sample point in sample Rooms 1A and 1B. The requirements for the PSS water chemistry are given in Section 9.3.4 for the reactor coolant and in Section 10.3.5 for the steam generators.

The samples taken from the RCS pass through a run of piping and tubing long enough to ensure a minimum decay time of 28 seconds for short-lived radioactivity, including N-16, before the fluid leaves the Containment. This decay time is based on GFFD and PSS flowing in parallel.

The samples are cooled to a maximum temperature of 120 F in the sampling rooms' PSS panels multi-tube primary stage exchanger and then reduced in pressure by pressure reducing valves.

The reactor coolant samples may be collected in detachable sample cylinders for gas analysis. Grab samples of steam generator blowdown may be collected at the PSS when the SSS is unavailable.

Samples taken from the Residual Heat Removal System are cooled and reduced in pressure in the sampling room's panels. Samples from the Reactor Makeup Water Storage Tank, which are taken from the bottom of the tank, are reduced in pressure.

Low temperature and low pressure or reduced pressure liquid samples are routed directly to the sampling rooms' PSS panels. Temperature, pressure and flow rate indications are provided wherever required.

To obtain representative primary samples, the lines are purged to remove solid deposits from the lines, prior to diverting the flow to the sample sink, where the samples are drawn off at a flow rate of .32 (60-120°F) gpm. The system pressure provides the motive force for purging. RCS hot leg sample lines are purged and sampled at .32 gpm to limit N-16 activity.

All liquid sample lines from the RCS, and the Residual Heat Removal System are connected to a common header and normally discharged to the CVCS volume control tank. Once grab sampled, the steam generator blowdown samples are discharged from the sample panel and routed to the sample sinks drain header. All other samples are routed directly into the sample sink.

The sample sink is a stainless steel sink with a raised edge to retain any splashed fluid. The sink area is provided with a hood equipped with an exhaust to the plant vent system. Demineralized water is provided to flush and clean the sink. The sink drains are emptied into the Equipment Drain System. From there, the waste is pumped into the Waste Management System for processing.

9.3.2.2.2 Secondary Sampling System

The Secondary Sampling System provides a means for continuous monitoring of liquid and steam purity in the condensate, heater drains, feedwater, steam cycle, steam generator blowdown, condensate storage tank, and main steam system. Additionally, the system provides the following functions:

a) Conditions the sample temperature and pressure to allow proper sample parameter analysis

b) Maintains the sample flow at a pre-specified minimum velocity

c) Alarms when sample parameters exceed set limits

d) Provides a continuous readout and record of selected parameters

e) Provides grab sampling capability for manual laboratory analyses

f) Incorporates a means to reclaim sample liquid for reuse in the secondary system or discharge to secondary waste

g) Provides remote chemistry data acquisition, monitoring, and data storage of selected parameters in the chemistry laboratory

Table 9.3.2-2 and 9.3.2-2A list the analyses performed on each specific sample point.

Table 9.3.2-2B indicates the design and operating conditions of each sample.

The steam generators are automatically monitored on a continuous basis and the steam generator samples are used for chemistry control. Samples of each steam generator are provided to the SSS as shown on Figure 9.3.2-2B. Grab samples for each steam generator can be drawn as required at the SSS and be transferred to the Hot Lab in the WPB (elevation 276 ft.). The Hot Lab (Radiochemistry facilities) provides the necessary equipment and facilities for radiological analysis of the steam generator samples as described in Section 12.5.2.1.2. A grab sample can also be obtained from the steam generator blowdown flash tank discharge as shown on Figure 9.3.2-2B. This grab sample could be analyzed in the Hot Lab to determine if there is a primary to secondary leak. The steam generator blowdown flash tank discharge is also continuously monitored by a radiation monitor REM-1BD-3527 as shown on Figure 10.1.0-6A. The monitor will alarm and alert operators when preset levels are exceeded indicating a primary to secondary leak. Grab samples of each steam generator can then be obtained from the SSS or PSS and analyzed in the Hot Lab to determine the leaking steam generator.

9.3.2.2.3 Post-Accident Sampling System

Design criteria and capabilities of the Post-Accident Sampling System comply with the guidelines of Item II.B.3 in NUREG-0737 and SRP 9.3.2. Figures 9.3.2-1 and 9.3.2-3 conceptually illustrate the sample lines and sampling panels, respectively.

The PASS is comprised of a sample preparation skid (No. 1), a gas separation skid (No. 3), an analysis skid (No. 2), and a control panel skid (No. 4).

The capability is provided to obtain and analyze reactor coolant samples in three hours or less from the time a decision is made to take a sample. Grab samples are taken to the onsite lab which is capable of providing, within the three-hour time frame, quantification of the following:

a) Radionuclides (noble gases, iodines, cesiums, and non-volatiles)

b) Boron concentration

c) Hydrogen

Grab sample analysis of chlorides is accomplished within the four-day time frame.

The Reactor Coolant Sample is taken from the Hot Leg Piping of the Reactor Coolant Loop (sample point P1 on PSS), and the Reactor Sump Sample is taken from the RHR pump discharge. The sample enters Skid No. 1 at a maximum flow rate of 1665 cc/min. where it passes through a cooler to cool the sample to approximately 75°F. The sample is then strained to remove any suspended solids.

The sample is directed to Sample Skid No. 2 where it is depressurized by passing through a pressure reducing valve. In the case of the RCS sample, high amounts of dissolved gases in

the sample will cause a two-phase flow when depressurized. The RHR sample, which has previously been depressurized in the Reactor Sump will remain in the liquid phase in Sample Skid No. 2.

An RCS sample is directed to Skid No. 3 for further separation of dissolved gases in a gas-liquid separation. The gas separation is a packed column with a mist eliminator and nitrogen sparger to ensure gas-liquid separation and avoidance of liquid carryover in the separated gas. Liquid and gas portions of samples are separately returned to Sample Skid No. 2 for analysis.

In Sample Skid No. 2, the RCS liquid returning from Skid No. 3 or the RHR liquid sample will pass through a magnetic flow meter where flow rate is measured and recorded.

The liquid sample then passes through a five-way valve and is directed through a dissolved oxygen probe and pH probe for in-line analysis of these parameters. The liquid sample is then discharged to the Reactor Containment Sump. The dissolved oxygen probe is calibrated using standardized solutions. The pH probe is accurate to ± 0.5 pH units. The dissolved oxygen probe has an accuracy of ± 20 percent in the 0-20 ppm range. The pH probe can be calibrated with standardized solutions when necessary. During normal operation, the pH probe response is checked against the pH of a normal reactor coolant grab sample in accordance with plant procedures.

A diluted Liquid Grab Sample may be obtained by passing the Liquid Sample through a four-way valve. By changing the position of the valve, a small amount of liquid is captured in the bore of the four-way valve. The captured sample is flushed out with a required amount of deionized water depending on the dilution desired (i.e., 1:500, 1:1000, etc.), to a shielded sample container. The diluted grab sample is analyzed for boron, chlorides and radioisotopes. All lines in the system may be flushed using deionized water.

An undiluted grab sample will be obtained by diverting the liquid sample through the four-way valve to an undiluted grab sample cylinder. An approximately 10 cc sample is captured by isolating the cylinder using three way valves. The 10 cc sample cylinder and isolation valves are in a portable shielded cask assembly. After isolating the sample, the lines are flushed with D. I. water, then the sample cask is disconnected and transported for either onsite or offsite analysis of chlorides, boron and radioisotopic constituents.

The gasses stripped from the RCS liquid sample are sent to Skid No. 2 where the flow rate is measured and recorded by a linear mass flow meter. The gas can then be passed through an in-line hydrogen analyzer, which has an accuracy of 2 percent of full scale. the gas is then discharged to the containment atmosphere.

The PASS also allows for a diluted gas grab sample to be drawn from the gas blender and collected in a gas sample container. The sample is then sent to the Hot Lab for gas analysis.

All lines in the system may be purged using nitrogen.

Design features and capabilities of the PASS that comply with NUREG-0660, and NUREG-0737, Item II.B.3, are listed below:

a) The system is capable of receiving a continuous sample, thus insuring a representative reactor coolant sample of the core area.

b) A flow restrictor is provided inside the Containment to limit reactor coolant losses from a rupture of the sample line.

c) Demineralized water and nitrogen are provided to purge sample lines and reduce plateout in the sample lines.

d) The residues of the liquid and gas samples are returned to the containment or to a closed system.

e) The existing reactor coolant sampling system does not require an isolated auxiliary system to be placed in operation during post-accident conditions.

f) Samples will be analyzed continuously for dissolved gases (H_2, O_2), thus, a pressurized reactor coolant sample will not be obtained under post-accident conditions.

g) The grab sample and the in-line calibration stations are located near Skid No. 2. The diluted grab sample receiver and Skid No. 2 are shielded. The shielding requirements are based on the NUREG-0737 source terms in the reactor coolant and on the condition of a monthly averaged dose rate of 15 mr/hr at the shield wall.

h) The sampling cabinet (Skid No. 2) is located in an enclosure of NEMA 12 classification with a top vent. The vent is connected to the plant HVAC system. Thus, any gaseous effluents from the cabinet will be filtered through charcoal absorbers and HEPA filters.

i) Grab sample chloride analysis will be performed on or off site within 4 days of the sample being taken.

The PASS is not required to assure any of the following conditions:

a) The integrity of the RCPB

b) The capability to shut down the reactor and maintain it in a safe shutdown condition.

c) The ability to prevent or mitigate the consequence of an accident which could result in potential offsite exposures in excess of 10 CFR 50.67 guideline exposures.

The PASS is isolated from the RCPB and the containment and, therefore, is NNS and does not meet seismic Category I requirements.

All lines in the PASS are constructed of corrosion-resistant stainless steel. Each portion of the system is designed for source pressure and temperature. Overpressure protection is provided through a pressure relief valve which discharges to the containment.

The system is designed to minimize pipe runs and grab sample sizes, thus minimizing radiation exposure and the effects of equipment failure.

All valves located in an inaccessible post-accident area are environmentally qualified.

Each component will be inspected and cleaned prior to installation. The system will be operated and tested initially with regard to flow paths, flow and thermal capacity, and mechanical operability. Instruments will be calibrated during testing.

Periodic system testing during normal plant operation will be used to confirm that the sample heat exchangers and pressure reducing valve in the system are properly set to give the desired conditions for sampling.

All necessary instrumentation and control for satisfactory operation of the Reactor Coolant Post Accident Sampling System is provided and located on the local control panel.

All equipment is arranged in a manner conducive to safety as well as ease of inspection, maintenance, operation, and calibration.

I&C Readout on the Control Panel is listed below:

Liquid Flow	Indicator-Recorder
Gas Flow (H_2)	Indicator-Recorder
Dyna-Blender	Indicator-Controller
pH	Indicator-Recorder
Dissolved O_2	Indicator-Recorder
H_2 Analyzer	Indicator-Recorder
Temperature	Indicator
Pressure	Indicator

9.3.2.3 Safety Evaluation

The Process Sampling System is not essential for safe plant shutdown. Safety features are provided to protect plant personnel and to prevent the spread of contamination from the sampling room when samples are being collected. The system is designed to limit radioactivity releases below the 10 CFR 20 limits under normal and failure conditions. The temperature and pressure of the various samples are reduced to minimize the possibility of local airborne activity. Instrumentation is provided in the sampling room to monitor the temperature and pressure of the samples before they are collected. Samples are normally taken only when the hood fan is operating. The Reactor Auxiliary Building Normal Ventilation System provides a backup means of maintaining low airborne activity levels.

The sample lines penetrating the Containment are each equipped with two solenoid operated or one solenoid and one air operated isolation valves which close on actuation of the containment isolation actuation signal. The penetration piping and isolation valves are Safety Class 2 and Seismic Category I. The containment isolation valves are also designed to fail closed on loss of power (refer to Section 6.2.4). Remote Control of these valves is provided to isolate any line failure which might occur outside of the Containment. Should any of the remotely operated

valves in the sampling system fail to close after a sample has been taken, backup manual valves in the sampling room may be closed. Passive flow restrictions are provided in order to limit reactor coolant loss from a rupture of sample line. The system are designed to minimize pipe runs and grab sample sizes, this minimizing radiation exposure and equipment failure.

The Process Sampling System serves no safety function since it is not required to achieve safe shutdown or mitigate the consequences of an accident. As the system serves no safety function, there are no safety class or seismic design requirements outside the containment area. Except where the Process Sampling System penetrates Containment (here the components are Safety Class 2, Seismic Category I) the system is classified non-nuclear safety, non-Seismic Category I. Failures of any non-safety portion of the Process Sampling System will not affect any safety related equipment.

9.3.2.4 Testing and Inspection

The PSS is inspected and cleaned prior to service. Demineralized water is used to flush each part of the system. The system is operated and tested initially with regard to flow paths, flow rate, thermal capacity and mechanical operability. Instruments are calibrated during plant hot functional testing.

All automatic analyzers are calibrated and their output results verified. The proper operation and availability of the Process Sampling System is proved in service by its daily use during normal plant operation.

The sampling systems are inspected during normal operation by observing proper operation of the components while samples are being drawn. The malfunction of automatic analyzers will be observed by incorrect readouts on the recorders or by alarms.

The equipment is proven operable through normal plant operation. Periodic maintenance insures proper operation of equipment.

The PASS will be maintained in accordance with plant procedures which are based upon the manufacturer's recommendations in the Operation and Maintenance Manual and operating experience.

9.3.2.5 Instrument Application

The PSS, SSS, and PASS use local pressure, temperature and flow indicators to facilitate manual operation and to determine sample conditions before samples are drawn.

Local and remote controls and alarms are provided for monitoring of the system and protection of components in the system. An alarm from the PSS and SSS panels is provided on the main control board to indicate trouble in the Process Sampling System. The following alarms are indicated in the system annunciator (sample points are defined in Tables 9.3.2-1, 9.3.2-1A, 9.3.2-2, 9.3.2-2A, and 9.3.2-2B):

Sample System Alarms				
Sample Point	Alarm For	High	Low	Recorder
Reactor Makeup Storage Tank	specific conductivity	X		No

Sample System Alarms				
Sample Point	Alarm For	High	Low	Recorder
Condensate Pumps Discharge	pH	X	X	Yes
	specific conductivity	X	X	Yes
	sodium	X		Yes
	cation conductivity	X		Yes
	hydrazine			Yes
	dissolved oxygen	X		Yes
Condensate Polishers A thru F	cation conductivity	X		Yes
	specific conductivity	X		Yes
	sodium	X		Yes
Combined Condensate Polisher Outlet	cation conductivity	X		Yes
	specific conductivity	X		Yes
	dissolved oxygen	X		Yes
	sodium	X		Yes
Heater Drain Pumps	cation conductivity	X		Yes
	specific conductivity	X	X	Yes
Feedwater	sodium	X		Yes
	hydrazine		X	Yes
	pH	X	X	Yes
	cation conductivity	X		Yes
	specific conductivity	X	X	Yes
	dissolved oxygen	X		No
Main Steam	cation conductivity	X		Yes
	specific conductivity	X	X	Yes
Steam Generator Blowdown A, B and C	pH	X	X	Yes
	cation conductivity	X		Yes
	specific conductivity		X	Yes
	sodium			Yes
Condensate Storage Tank	cation conductivity	X		Yes
	specific conductivity	X		Yes
	dissolved oxygen	X		Yes
SG Blowdown Demins A thru C	cation conductivity	X		Yes
	specific conductivity	X		Yes
	sodium	X		Yes

9.3.3 EQUIPMENT AND FLOOR DRAINAGE SYSTEMS

9.3.3.1 Design Basis

The Equipment and Floor Drain Systems collect waste liquids from the various plant operational system and convey them from their points of origin by gravity, by pumps, or a combination thereof, to the appropriate waste processing system collection tank. Gravity flow paths for the movement of waste water directly to the waste processing system tanks are utilized whenever such design can be accomplished. When total gravity flow is precluded by abnormal or unusual

condition, liquids are routed by gravity to intermediate collection sumps or tanks and subsequently pumped to the waste processing system collection tanks.

The radioactive drainage systems and nonradioactive drainage systems are designed to be totally isolated for each other. Therefore there is no potential for inadvertent transfer of radioactive contaminated fluids to a nonradioactive drainage system.

The equipment and floor drainage systems do not serve any safety function and are classified as nonnuclear safety. Therefore, they are not required to withstand the effects of adverse environmental phenomena such as earthquakes, tornados, hurricanes, floods, or the effects of high and moderate pipe breaks. However, the portion of the containment sump discharge piping penetrating the Containment Building is designed to Seismic Category I and Safety Class 2, requirements. For a flood analysis in the event of piping failure, see Section 3.6.

A storm water drainage system is provided and sized for the design rain intensity storm condition of five in/hr.

9.3.3.2 System Description

The drainage systems are divided into two major classifications; radioactive drainage systems and nonradioactive drainage systems. These classifications are further defined into subsystems for the purpose of identification, isolation, routing and processing.

Radioactive Drainage Systems

a) Equipment Drain System

b) Floor Drain System

c) Detergent Waste Drainage System

d) Chemical Waste Drainage System

e) Secondary Waste Drain System (including Component Cooling Water Drainage)

Nonradioactive Drainage Systems

a) Storm Water Drainage Systems

b) Acid Waste and Vent System

c) Acid and Caustic Waste System

d) Oil Drainage Systems

e) Industrial Waste System

f) Sprinkler Discharge Drainage System

g) HVAC Condensate Drainage System

h) Condenser Water Box Drainage System

Equipment and floor drainage systems are shown on Figures 9.3.3-1 through 9.3.3-5.

The drainage system components consist of drain fittings specifically selected for a planned or anticipated liquid discharge, and a network of pipes, fittings, valves, sumps, tanks and pumps to achieve rapid and unobstructed flow paths from the point of liquid influent to the point of treatment or disposal.

Each system component is engineered so as to be capable of conveying the designed volume of leakage expected. Uncontrolled large volumes of liquids released by pipe or equipment failure, or by tank overflow will spill upon the floor. All floors are pitched approximately 1/8 in. per foot to a floor drain for rapid carry-off of such spillage.

Each gravity drainage system is designed using the normal anticipated maximum discharge in gallons per minute through an enclosed pipe flowing a maximum of 75 percent full. Horizontal drainage piping is sloped at a uniform rate of 1/4 in. per foot as standard practice. Where conditions are such that standard pitch cannot be maintained, a pitch of 1/8 in. per foot minimum is used. Fittings are drainage pattern whenever possible and are installed so as to provide a continuous extension of piping runs. Discharge headers from pumps are routed as straight as possible to their final destination, keeping to a minimum turns and traps.

Cleanouts are provided on each drainage system to permit cleaning in the event a blockage occurs. The size of cleanouts is in direct proportion to the size of the pipe it serves, up to four inches. Thereafter, four inch cleanouts are standard for all larger pipes. Cleanouts are located where the change of direction in horizontal runs in 90 degrees or greater, at maximum intervals of 50 ft. on straight runs and at the base of all stacks. Piping runs encased or embedded in concrete or located in inaccessible areas have cleanouts extended to accessible locations.

9.3.3.2.1 Radioactive drainage systems

The radioactive drainage systems provide the interface between reactor auxiliary equipment and the waste processing treatment facilities. They provide for the drainage of equipment, tanks, and wetted surfaces during normal plant operation.

9.3.3.2.1.1 Equipment drain system

Drainage to the Equipment Drain System is confined to high purity wastes capable of active gas releases. There are no floor drains connected to the system except in the Containment Building and all equipment drains are of the closed type without traps. The uppermost portion of the drainage system in each building is provided with vents which are connected to that building's contaminated ventilation system. To mitigate the consequences of leakage during ECCS recirculation following an accident, the Equipment Drain System in the Reactor Auxiliary Building is also connected to the RAB Emergency Exhaust System.

Reactor Auxiliary Building - Liquid discharges from equipment, pumps, and miscellaneous leak-off points located at Elevation 190 ft. MSL are collected by drain fittings located at the equipment discharge points and routed by gravity through piping buried in the mat to two equipment drain sumps with a bottom elevation of 184 ft. Two 75 gpm sump pumps in each sump discharge the sump contents to the equipment drain tank discharge header.

Liquid discharges from equipment, tanks, and miscellaneous leak-off points located at Elevation 216 ft. MSL and above are routed by gravity to the equipment drain transfer tank located on Elevation 190 ft. MSL. The tank liquids are drained by means of the equipment drain sump pumps through the discharge header to the waste holdup tanks in the Waste Processing Building. See Section 9.3.3.2.2.6 for the sprinkler drainage system description.

Containment Building - Liquid discharge from equipment, tanks, miscellaneous leak-off points, and floor drainage are collected by drain fittings located at the equipment discharge point and by floor drains located at low points in the floors, and routed by gravity to the containment sump which is located at Elevation 213 ft. MSL. In entering the sump, all liquids pass through a leak detection tank which is located within the sump. Two 150 gpm capacity pumps discharge the sump contents to the waste holdup tank in the Waste Processing Building. Containment isolation valves on the sump pump discharge lines close on receipt of containment isolation phase A signal as shown in Table 7.3.1-7. Containment wide range level indication is provided in the Control Room as shown in Table 7.5.1-1. Also Class IE containment sump alert level indication is provided in the Control Room.

Fuel Handling Building - Liquid discharges from equipment, tanks, and miscellaneous leak-off points are collected and routed by gravity to two equipment drain sumps at Elevation 216 ft. MSL. Two 75 gpm pumps in each sump discharge the sump contents to the waste holdup tank in the Waste Processing Building.

Waste Processing Building - Liquid discharges from equipment, tanks, and miscellaneous leak-off points are collected and routed by gravity to three equipment drain sumps at Elevation 211 ft. MSL. Two 50 gpm pumps in each sump discharge the sump contents to the waste holdup tanks in the Waste Processing Building.

Liquid wastes from the Fuel Handling Building's cooling water heat exchangers, pumps, secondary waste evaporators, and from the Waste Processing Building's evaporators, precoolers, catalytic heat exchangers, waste gas compressors and chillers are routed to the cooling water sump in the Waste Processing Building. Two sump pumps discharge the sump content to the WPB cooling water surge tank.

Tank Building - Liquid discharges from equipment and miscellaneous leak off points are collected and routed by gravity to the equipment drain sump at Elevation 236 ft. MSL. Two 50 gpm sump pumps discharge the sump contents to the waste holdup tank in the Waste Processing Building.

9.3.3.2.1.2 Floor drain system

Drainage to the floor drain system is confined to low purity wastes not capable of active gas releases. Floor drains are not trapped and equipment drains are of the open type.

Reactor Auxiliary Building - Liquid discharges from equipment, tanks, miscellaneous leak-off points, and floor drainage from Elevation 216 ft. MSL and above are collected by drain fittings located at the equipment discharge points and by floor drains located at low points in the floors and routed by gravity to the floor drain transfer tank at Elevation 190 ft. MSL. The tank discharges to a drain sump; the sump is provided with two 75 gpm capacity pumps which discharge the sump contents to the floor drain tanks in the Waste Processing Building.

Pipe Tunnel - Floor drains to the pipe tunnel have been plugged. Rain water inleakage from the pipe tunnel is pumped to the HVAC Condensate Transfer Tank.

Fuel Handling Building - Liquid discharges from equipment, tanks, and miscellaneous leak-off points, and floor drainage are collected by drain fittings located at the equipment discharge points and by floor drains located at low points in the floors and routed by gravity to two floor drain sumps at Elevation 216 ft. MSL. Two 75 gpm pumps in each sump discharge the sump contents to the floor drain tanks in the Waste Processing Building.

Waste Processing Building - Liquid discharges from equipment, tanks, and miscellaneous leak-off points, and floor drainage are collected by drain fittings located at the equipment discharge points and by floor drains located at low points in the floors and are routed by gravity to two floor drain sumps located at Elevation 211 ft. MSL and one floor drain sump located at Elevation 216 ft. MSL. Two 50 gpm pumps in each sump discharge the sump contents to the floor drain tanks.

Tank Building - Liquid discharges from equipment, tanks, and miscellaneous leak-off points and floor drainage are collected by drain fittings located at the equipment discharge points and by floor drains located at low points in the floors and routed by gravity to the floor drain sump located at Elevation 236 ft. MSL. Two 50 gpm sump pumps discharge the sump contents to the floor drain tanks in the Waste Processing Building.

9.3.3.2.1.3 Detergent waste system

Reactor Auxiliary Building - Liquid discharges containing chemical cleaning compounds from the decontamination facilities located at Elevation 236 ft. and Elevation 261 ft. MSL are routed by gravity to the detergent drain sump located on Elevation 236 ft. MSL. All fixtures, equipment drains, and floor drains are provided with traps and are vented to the building contaminated exhaust system. Two 75 gpm sump pumps discharge the sump contents to the laundry and hot shower drain tanks in the Waste Processing Building.

Fuel Handling Building - Liquid discharges containing chemical cleaning compounds from the personnel decontamination area are routed by gravity to the detergent drain sump located at Elevation 261 ft. MSL. All fixtures and floor drains are provided with traps and are vented to the building contaminated exhaust system. Two 100 gpm sump pumps discharge the sump contents to the laundry and hot shower tanks in the Waste Processing Building.

Drainage from the spent fuel cask decontamination areas is routed by gravity to the decontamination receiving and transfer tank located at Elevation 236 ft. MSL. Two 100 gpm transfer pumps discharge the tank contents to the laundry and hot shower tanks in the Waste Processing Building. For tank level instrumentation and pressure indicator on the pump discharge header, refer to Figure 9.3.3-3.

Waste Processing Building - Liquid discharges containing chemical cleaning compounds from the decontamination facility are routed by gravity to the detergent drain sump at Elevation 211 ft. MSL. Two 100 gpm sump pumps discharge the sump contents to the laundry and hot shower tanks.

Discharges from the hot and low activity laboratories, dishwashing machine, and from the cold and hot laundry and health physics decontamination areas are routed by gravity directly to the laundry and hot shower tanks.

9.3.3.2.1.4 Chemical waste systems

Waste Processing Building - Liquid discharges from part of the hot laboratory located at Elevation 276 ft. MSL are routed by gravity to the chemical drain tanks 1 and 2 on Elevation 211 ft. MSL. System vent piping is provided for vapor removal. The vents are connected to the building ventilation system.

Liquid discharges from part of the low activity laboratory located at Elevation 276 ft. MSL are routed by gravity to the chemical drain tanks 3 and 4 on Elevation 211 ft. MSL. System vent piping is provided and connected to the building ventilation system.

The remaining part of the hot and low activity laboratory fixtures is routed to the floor.

9.3.3.2.1.5 Secondary waste system

Waste Processing Building - Liquid discharges from equipment, tanks, miscellaneous leak-off points and floor drainage, including Component Cooling Water Drainage, are collected by drain fittings located at the equipment discharge points and by floor drains located at low points in the floors and are routed by gravity to the secondary waste sump located at Elevation 211 ft. MSL. Two 100 gpm sump pumps discharge the contents of the secondary waste sump 1-4 M,N to the High Conductivity Holding Tank in the Waste Processing Building at Elevation 216 ft. MSL.

Turbine Building - Liquid discharges from equipment, tanks, miscellaneous leak-off points, and floor drainage associated with the condensate polishing system are collected by drain fittings located at the equipment discharge points and by floor drains located at low points in the floors and are routed by gravity to the acid-caustic drain sump located at Elevation 240 ft. MSL. Two 50 gpm pumps discharge the sump contents to the high conductivity holdup tanks in the Waste Processing Building.

Reactor Auxiliary Building - Secondary waste drainage is directed to the Component Cooling Water Drain Tank.

9.3.3.2.1.6 Sump operation

Sumps have been sized to accommodate all anticipated normal and transient leakage from the equipment they serve. All sumps throughout the plant have been provided with duplex full capacity pumps.

Level switch and level operated mechanical alternator are provided for controlling the sump level and equalizing operating time for the two sump pumps. The level control is delineated in the following steps:

a) When the level reaches the predetermined "High," the mechanical alternator starts the selected pump. The pump is also tripped automatically on low level.

b) If the level continues to rise and reaches the predetermined "High High," the alternator will start the second pump. An independent level switch is provided to detect that the level in the sump is high enough to necessitate operation of the standby pump and to initiate an alarm in the Control Room.

A local control switch is provided for each pump to enable its manual operation when level in the sump is between low and high extremes.

An exception to the above description is those sumps in the service water pipe tunnel which contain a single submersible sewage pump. Level switches activate these pumps without alternating between the two pumps.

9.3.3.2.2 Nonradioactive drain systems

The nonradioactive drainage systems provide the interface between various drainage discharge points and their respective internal and/or external waste treatment facilities. They provide for the draining of equipment, tanks, and flooded surfaces during normal plant operation, as well as anticipated large volume flow associated with abnormal or accident conditions.

9.3.3.2.2.1 Storm water drainage system

The storm water drainage system consists of various types of drain inlets and catch basins for storm water capture from structure roofs, plant grounds and roads, and an interconnected network of storm water piping for conveyance. It provides the entire plant site with the means to effectively collect accumulations of rainwater, and creates the flow path for offsite disposal. Surfaces exposed and subjected to rainwater are sloped to the collection appurtenance: roof drains, deck drains, area drains, and catch basins. Drains have been selected so as to fully meet all pertinent requirements of the surface to be drained. Obstructions between high surface points and drain inlets have been minimized to affect accelerated and total drainage of the surface.

The building systems are designed as gravity systems with a minimum pipe slope of 1/4 in. per foot for maximum self-cleaning velocity. Additionally, the systems are designed to minimize the deposit of solids and clogging, and with adequate cleanouts arranged such that the systems may be readily cleaned.

The systems are designed to preclude flooding due to abnormal weather conditions. The systems will provide storm water collection, conveyance, and offsite disposal without puddling or flooding of the plant site or structure roofs.

The North Carolina State Plumbing Code (1968) is used for permissible square feet of drainage for a given pipe size and pitch, in terms of square feet of projected drainage area.

Containment Building - Roof drains are provided around the circumference of the dome walkway. Leaders are embedded within the containment walls to points of exit from where they run to the yard storm water drainage system.

9.3.3.2.2.2 Acid Waste and Vent System

Liquid wastes from the battery rooms in the Reactor Auxiliary Building and Turbine Building are routed to local neutralizing tanks for neutralization and then discharged to the sanitary drainage system for disposal. Each fixture and floor drain is provided with a local pipe vent which connects to a main vent. The main vent is extended through the roof to the atmosphere.

9.3.3.2.2.3 Acid and Caustic Waste Systems

Drains receiving intermittent acid and caustic wastes from the secondary waste blowdown treatment area at Elevation 236 ft. MSL of the Waste Processing Building are routed to a neutralizing tank at Elevation 216 ft. MSL. The tank discharge is routed to the Secondary Waste Treatment System.

9.3.3.2.2.4 Oil Drainage System

For Unit 1, each diesel generator compartment and diesel fuel oil pump room is provided with floor drains to collect oil spills and sprinkler discharge water. Liquids are routed to individual interior sumps. Two sump pumps discharge the sump contents to the yard oil separator which discharges oil-free water to the Waste Neutralization System. For Unit 2 Diesel Generator Bays 2A and 2B, one sump pump in each bay discharges the sump contents to the yard oil separator.

9.3.3.2.2.5 Industrial Waste System

Turbine Building - The industrial waste system consists of floor drains, equipment drains, and curbed area oil collection drains. The system provides the means to collect and convey the various Turbine Building operational waste liquids from their points of collection of their ultimate disposal.

Floor drains are provided throughout the building to accept normal maintenance washdown. Concrete floors are sloped to floor drains which are located at low points on the floors to facilitate drainage and prevent water puddles.

Equipment drains are provided for mechanical equipment such as pumps, tanks, and leak-off points. These drains serve to accept continual or intermittent discharge as part of routine operation. They additionally provide the means for equipment drain-down in the event of maintenance when required, or for replacement of the equipment when necessary. For equipment requiring flushing on a regular or occasional basis, this system provides that capability as well.

Floor drains and/or equipment drains are provided in curbed oil areas to service mechanical equipment using oil in their operation. Valves are placed on floor drain outlets to provide the capability of containing substantial oil spill within the curbs. Equipment drains are elevated above curbs to preclude their use as overflows. However, when this elevation presents drainage problems to the equipment it serves, closed equipment drains are utilized. Safety related cable vaults may be dewatered by the Secondary Drain System. Discharge piping from the cable vaults is routed to the industrial waste sump located in the northeast quadrant on the 261' elevation of the Turbine Building.

All Turbine Building drainage is routed to two industrial waste sumps located on Elevation 261 ft. MSL. Each sump is provided with two 200 gpm capacity pumps. The Industrial Waste Sump Pump discharge header, which contains a Radiation Monitor and Automatic Liquid Sample Unit with flow totalizer to monitor fluid chemistry for compliance with Tech. Spec. and ODCM requirements, is configured with two alternate discharge flowpaths. Under normal conditions, industrial waste will be discharged to an Oil Separator Unit located in the yard area and then transferred by the oil separator discharge pumps to the Waste Neutralization System. An alternate flowpath is available to the Secondary Waste System provided certain procedural and

operational requirements are met. In the event a high radiation level is detected in the industrial waste pump discharge header, automatic flowpath valves are activated which close the flowpath to the oil separator, Industrial Waste Sump Pump operation is terminated, and an alarm is activated in the Control Room.

9.3.3.2.2.6 Sprinkler drainage systems

Containment Building - Potentially radioactive drainage from expected firefighting water flow will be collected by the floor drain system and routed to the containment sump for discharge to the waste hold-up tanks in the Waste Processing Building.

Reactor Auxiliary Building - Potentially radioactive drainage from expected firefighting water flow will be collected by the radioactive floor drain system and routed to the floor drain transfer tank at Elevation 190 ft. MSL. Should the expected flow exceed the capability of the tank, water will overflow into and flood the tank cubicle. This cubicle is watertight and designed to hold the maximum expected firefighting water flow. A valved connection on the floor drain serving the cubicle will permit controlled drainage to the sump adjacent to the cubicle. The normal sump discharge flow path is to the waste hold-up tanks in the Waste Processing Building.

Fuel Handling Building - Potentially radioactive drainage from expected firefighting water flow will be collected by the radioactive floor drain system and discharged by system sump pumps to the floor drain tanks in the Waste Processing Building.

Waste Processing Building - Drainage from expected firefighting water flow in non-radioactive areas will be collected by the sanitary drainage system and discharged to the site sanitary drainage system. Drainage from radioactive areas will be collected by the radioactive floor drain system and discharged to the floor drain tanks.

Fuel Oil Storage Tank Building - Drainage from expected firefighting water flow will be collected by the floor drain system and routed to the building sumps. The sump pumps will discharge the water to the yard oil separator which pumps its contents to the Waste Neutralization System.

Diesel Generator Building - Drainage from expected firefighting water flow will be collected by the floor drain system and routed to the building sumps. The sump pumps will discharge the water to the yard oil separator which pumps its contents to the Waste Neutralization System.

9.3.3.2.2.7 HVAC condensate drainage systems

Reactor Auxiliary Building - Condensate from HVAC units are collected by equipment drains at the equipment discharge points and routed by gravity to the HVAC condensate transfer tank located at Elevation 216 ft. MSL. Transfer pumps discharge the tank contents to the Turbine Building Industrial Waste System.

Fuel Handling Building - Condensate from HVAC units are collected by equipment drains at the equipment discharge points and routed by gravity to the HVAC condensate transfer tank located at Elevation 216 ft. MSL. Transfer pumps discharge the tank contents to the turbine building industrial waste system.

Waste Processing Building - Condensate from HVAC units is routed to collection basins. Small sump pumps discharge the basin contents to the HVAC condensate transfer tank located at 216 ft. MSL in the RAB.

9.3.3.2.2.8 Condenser water box drainage system

Turbine Building - The system is designed to empty one of the two cooling water circuits in one hour, to permit access into the condenser for maintenance or repairs. The Condenser Water Box Drainage flows by gravity, under positive static head, into the Storm Water Drainage System of the Turbine Building.

9.3.3.3 Safety Evaluation

Reactor building sump pump discharge piping penetrating the containment is designed to Seismic Category I and Class 2 requirements and provided with isolation valves, as shown on Figure 9.3.3-2. All other portions of the equipment and floor drainage systems are not designed to either Seismic Category I or safety class requirements as they do not perform any safety function.

Each building housing safety-related equipment is provided with drainage and sumps to prevent flooding. The control room operator is alerted to water accumulation in these areas via Class IE monitor lights and annunciators to facilitate isolation of the affected system.

The failure of non-safety related components of the Equipment and Floor Drain Systems, which could affect the operation of safety related equipment, has been investigated as to the sphere of influence of the failed component. This has been accomplished by an analysis of system component layout on a case by case basis as design of the system progressed. If an analysis indicated that such interaction was possible, or if other considerations precluded such analysis, the following types of solutions were implemented as appropriate:

a) physically relocated either the equipment and floor drain system or the safety related component from the sphere of influence,

b) encased or embedded components of the equipment and floor drain system in concrete walls, floors, or pipe chases;

c) isolated the equipment and floor drain system by concrete barriers;

d) seismically supported, where required, components of the equipment and floor drain system.

A study was performed to determine which systems, having redundant safety-related components located in enclosed areas, have floor drains and/or open equipment drains which interconnect between areas housing redundant trains (for probable flooding) through a common drain header.

It was concluded that in all except two instances, the above condition does not exist in the drainage design of redundant safety-related equipment areas.

The condition exists in the areas housing the charging pumps at EL 236.00 ft. and HV units at EL 305.00 ft. of the Reactor Auxiliary Building. However, a water backflow that might result from blockage of a drain header will not flood any train of any safety-related system. The resultant water has a direct flow path to adjacent open areas for adequate disbursement and removal by the open area floor drain system.

9.3.3.4 Tests and Inspections

The Equipment and Floor Drainage Systems undergo preoperational and startup tests to verify the continuity and reliability of the system. Instruments are calibrated and automatic controls will be tested for actuation at the proper set points during this testing.

Welded joints in the radioactive Equipment and Floor Drainage Systems that are part of the radwaste QA program are visually inspected.

9.3.3.5 Instrumentation Applications

Monitor lights and alarms are provided in the Radwaste Control Room for the monitoring of all sump operation modes as described in Section 9.3.3.2.1.6. For leak detection, refer to Section 5.2.5. A predetermined leakage rate will sound an alarm in the Control Room.

9.3.4 CHEMICAL AND VOLUME CONTROL SYSTEM (INCLUDING BORON RECYCLE SYSTEM)

The Chemical and Volume Control System (CVCS is presented in Section 9.3.4.1 and shown on Figures 9.3.4-1 through 9.3.4-5.

The Boron Recycle System (BRS) is presented in Section 9.3.4.2 and shown on Figures 9.3.4-6 and 9.3.4-7.

9.3.4.1 Chemical and Volume Control System

The Chemical and Volume Control System (CVCS), shown on Figure 9.3.4-1 through 9.3.4-5, is designed to provide the following services to the Reactor Coolant System (RCS):

a) Maintain a programmed water level in the pressurizer, i.e., maintain required water inventory in the RCS.

b) Maintain seal-water injection flow to the reactor coolant pumps.

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

d) Provide injection flow to the RCS following actuation of emergency core cooling (part of the system is shared with the Emergency Core Cooling System).

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

9.3.4.1.1 Design Bases

Quantitative design bases are given in Table 9.3.4-1, while qualitative descriptions are given below.

9.3.4.1.1.1 Reactivity Control

The CVCS regulates the concentration of the 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.

Reactor Makeup Control

a) The CVCS is capable of borating the RCS through either one of two flow paths and from either one of two boric acid sources.

b) The amount of boric acid stored in the CVCS always exceeds that amount required to borate the RCS to cold shutdown concentration assuming that the control assembly with the highest reactivity worth is stuck in its fully withdrawn position. This amount of boric acid also exceeds the amount required to bring the reactor to hot shutdown and to compensate for subsequent xenon decay.

Boron Thermal Regeneration

The CVCS is designed to control the changes in reactor coolant boron concentration to compensate for the xenon transients during load follow operations without adding makeup for either boration or dilution. This is accomplished by the Boron Thermal Regeneration System which is designed to allow load follow operations as required by the design load cycle.

9.3.4.1.1.2 Regulation of Reactor Coolant Inventory

The CVCS maintains the coolant inventory in the RCS within the allowable pressurizer level range for normal modes of operation including startup from cold shutdown, full power operation and plant cooldown. This system also has sufficient makeup capacity to maintain the minimum required inventory in the event of minor RCS leaks (see Chapter 16 for a discussion of maximum allowable RCS leakage).

9.3.4.1.1.3 Reactor Coolant Purification

The CVCS is capable of removing certain fission and activation products, in ionic form or as particulates, from the reactor coolant in order to provide access to those process lines carrying reactor coolant during operation and to reduce activity releases due to leaks.

9.3.4.1.1.4 Corrosion Control

Corrosion control is provided by maintaining the pH and oxygen levels in the RCS within specified limits. The CVCS provides a means for adding chemicals to the RCS which 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.

9.3.4.1.1.5 Seal Water Injection

The CVCS is able to continuously supply filtered water to each reactor coolant pump seal, as required by the reactor coolant pump design. The Alternate Seal Injection (ASI) System provides a completely independent, automatically-actuated back-up seal injection system that is not reliant on the plant electrical or cooling system (Ref. 9.3.8).

9.3.4.1.1.6 Hydrostatic Testing

The charging pump discharge header incorporates a hydrostatic test connection which can be used to perform this test. A temporary spool piece is installed to this connection to permit testing utilizing the hydro test pump which is located in the Safety Injection System.

9.3.4.1.1.7 Emergency Core Cooling

The centrifugal charging pumps in the CVCS also serve as the high-head safety injection pumps in the Emergency Core Cooling System. Other than the centrifugal charging pumps and associated piping and valves, the CVCS is not required to function during a loss-of-coolant accident (LOCA). During a LOCA, the CVCS is isolated except for the centrifugal charging pumps and the piping in the safety injection path and the reactor coolant pumps seal injection path.

9.3.4.1.2 System Description

The CVCS is shown on Figures 9.3.4-1 through 9.3.4-5 with system design parameters listed in Table 9.3.4-1. The CVCS consists of several subsystems: the charging, letdown and seal water system; the reactor coolant purification and chemistry control system; the reactor makeup control system; and the boron thermal regeneration system.

9.3.4.1.2.1 Charging Letdown and Seal Water

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 normal plant operation. This is achieved by means of a continuous feed and bleed process during which the feed rate is automatically controlled based on a pressurizer water level. The bleed rate can be chosen to suit various plant operational requirements by selecting the proper combination of letdown orifices in the letdown flow path.

Reactor coolant is discharged to the CVCS from reactor coolant loop #1 crossover 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 letdown orifice(s) and flows through the tube side of the letdown heat exchanger where its temperature is further reduced. Downstream of the letdown heat exchanger a second pressure reduction occurs. This second pressure reduction is performed by the low pressure letdown valve, the function of which is to maintain an upstream pressure which prevents flashing downstream of the letdown orifices.

The coolant then flows through one of the mixed bed demineralizers. The flow may then pass through the cation bed demineralizer which is used intermittently when additional purification of the reactor coolant is required.

During reactor coolant boration and dilution operations, especially during load follow, the letdown flow leaving the demineralizers may be directed to the Boron Thermal Regeneration System. The coolant then flows through the reactor coolant filter and into the volume control tank through a spray nozzle in the gas space of the tank. Hydrogen (from the Hydrogen Storage System) is continuously supplied to the volume control tank where it mixes with fission gases which are stripped from the reactor coolant into the tank gas space. The contaminated hydrogen (i.e., the hydrogen and fission gases) is continuously purged to the Gaseous Waste Processing System. The partial pressure of hydrogen in the volume control tank determines the concentration of hydrogen dissolved in the reactor coolant for control of oxygen produced by radiolysis of water in the core.

Three centrifugal charging pumps are provided to take suction from the volume control tank and return the cooled, 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 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. Three charging paths are provided from a point downstream of the regenerative heat exchanger. Normally the flow is then injected into a cold leg of the RCS loop 2. An alternative charging flow may be injected into the cold leg of the RCS loop 1. A flow path is also 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 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. It is directed to a point between the pump shaft bearing and the thermal barrier cooling coil. Here the flow splits and a portion (nominally 5 gpm per pump) enters the RCS through the labyrinth seal. The labyrinth flows are removed from the RCS as a portion of the letdown flow. The remainder of the flow is directed up the pump shaft, cooling the lower bearing, and passes through the number 1 seal 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 to the volume control tank. A very small portion of the seal flow leaks through the number 2 seal. The number 2 seal leakoff flow is discharged to the reactor coolant drain tank in the Liquid Waste Processing System. A number 3 seal provides a final barrier to leakage of reactor coolant to the containment building atmosphere.

Additional injection water from a head tank (seal standpipe) flows into the number 3 seal between its "double dam" seal area. At this point the flow divides with half flushing through one side of the seal and out the number 2 seal leakoff while the remaining half flushes through the other side and out of the number 3 seal leakoff to the containment sump.

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 the crossover leg of the RCS loop 3 to flow through the tube side of the excess letdown heat

exchanger where it is cooled by component cooling water. Downstream of the heat exchanger a remote-manual control valve controls the excess letdown flow. The flow 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. The excess letdown flow can also be directed to the reactor coolant drain tank or directly into the volume control tank via a spray nozzle. When the normal letdown line is not available, the normal purification path is also not in operation. Therefore, this alternate condition would allow continued power operation for a limited period of time, dependent on RCS chemistry and activity. The excess letdown flow path is used to provide additional letdown capability during the final stages of plant heatup. This path removes some of the excess reactor coolant due to expansion of the system as a result of the RCS temperature increase.

Surges in RCS inventory due to load changes are accommodated for the most part in the pressurizer. The volume control tank provides surge capacity for reactor coolant expansion not accommodated by the pressurizer. If the water level in the volume control tank exceeds the normal operating range, a proportional controller modulates a three-way valve downstream of the reactor coolant filter to divert a portion of the letdown to the Boron Recycle System. If the high-level limit in the volume control tank is reached, an alarm is actuated in the Control Room and the letdown flow is completely diverted to the Boron Recycle System.

The Boron Recycle System (Section 9.3.4.2) receives and processes reactor coolant effluent for reuse of the boric acid and purified water. The system decontaminates the effluent by means of demineralization and gas stripping, and uses evaporation to separate and recover the boric acid and reactor makeup water.

When in the automatic mode, low level in the volume control tank initiates makeup from the Reactor Makeup Control System. If the Reactor Makeup Control System does not supply sufficient makeup to keep the volume control tank level from falling to a lower level, 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 level channels causes the suction of the charging pumps to be transferred to the refueling water storage tank.

9.3.4.1.2.2 Reactor coolant purification and chemistry control

<u>pH Control</u>

The pH control chemical employed is lithium hydroxide. This chemical is chosen for its compatibility with the materials and water chemistry of borated water/stainless steel/zirconium/inconel systems.

The concentration of Lithium-7 in the RCS is maintained in a range specified by plant procedures. If the concentration exceeds this range, the cation bed demineralizer is employed in the letdown line in series operation with a mixed bed demineralizer. Since the amount of lithium to be removed is small, the cation bed demineralizer is used intermittently to maintain Lithium-7 within specification. If operational restraints prevent the cation bed from being placed in service, Lithium may exceed the specified range for brief periods at the beginning of the fuel cycle and during normal operations when the CVCS demineralizers are not available for Lithium removal.

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 in the laboratory 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.

Oxygen Control

During plant startup from the cold condition, hydrazine may be 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 cold shutdown.

Dissolved hydrogen is employed during normal power operation to control and scavenge oxygen produced due to radiolysis of water in the core region. Sufficient partial hydrogen pressure is maintained in the volume control tank such 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 maintain the hydrogen concentration in the reactor coolant of 25 to 50 cc hydrogen at STP per kilogram (STP cc/kg) during normal power operation. Prior to reactor criticality, the hydrogen shall be at least 15 STP cc/kg. Hydrogen is supplied from the hydrogen tank in the gas storage facility (Refer to Figure 10.2.2-5).

Reactor Coolant Purification

Mixed bed demineralizers are provided in the letdown line to provide cleanup of the letdown flow. The demineralizers remove ionic corrosion products and certain fission products. One demineralizer is normally in continuous service and can be supplemented intermittently by the cation bed demineralizer, if necessary, for additional purification. The cation resin removes principally cesium and lithium isotopes from the letdown flow. The second mixed bed demineralizer serves as a standby unit for use if the operating demineralizer becomes exhausted during operation.

A further cleanup feature is provided for use during 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, through a mixed bed demineralizer and the reactor coolant filter to the volume control tank. The fluid is then returned to the RCS via the normal charging route.

Filters are provided at various locations to ensure filtration of particulate and resin fines and to protect the seals on the reactor coolant pumps.

Normally, when a CVCS demineralizer is in service, the reactor coolant filter is also in service to prevent resin fines and corrosion product from entering the VCT from the letdown system. However, during the acid reducing phase of RCS cleanup after the unit is shut down, the reactor coolant filter may be bypassed with a demineralizer in service for short periods of time while the reactor coolant filter is being backflushed. The demineralizer is left in service to remove the soluble iron which has gone to solution during the acid reducing phase and to act as a mechanical filter to prevent corrosion product from entering the VCT via the reactor coolant bypass line. Continuous use of the CVCS demineralizers during the acid reducing phase will reduce dose to personnel during the outage and during the next cycle by providing a lower

source term. The seal water injection filters will remain in service during this time to protect the reactor coolant pump seals.

Fission gases are removed from the reactor coolant by purging of the volume control tank to the Gaseous Waste Processing System.

9.3.4.1.2.3 Reactor Makeup Control System

The soluble neutron absorber (boric acid) concentration is controlled by the Boron Thermal Regeneration System and by the Reactor Makeup Control 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 section header or to the volume control tank. The makeup control functions are to maintain the desired operating fluid inventory in the volume control tank and to adjust the reactor coolant boron concentration for reactivity control. Reactor makeup water and boric acid solution (4 weight percent) may be 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.

Grab sampling capabilities (see Section 9.3.2) are provided to monitor the boron content of the reactor coolant in the letdown line.

The boric acid is stored in the Boric Acid Tank. Two boric acid pumps are provided. One pump is normally aligned to provide boric acid to the suction header of the charging pumps, and the second pump is in reserve. On a demand signal by the reactor makeup controller, the pump starts and delivers boric acid to the suction header of the charging pumps. The pump can also be used to recirculate the boric acid tank fluid.

All portions of the CVCS which normally contain concentrated boric acid solution (4 weight percent boric acid) are located within a heated area in order to maintain solution temperature at ≥ 65F. 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 ≥ 65F.

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 also starts on demand from the reactor makeup controller and provides flow to the volume control tank via the letdown line, spray nozzle, or to the suction header of the charging pumps depending on the mode of operation.

During reactor operation, changes are made in the reactor coolant boron concentration for the following conditions:

a) Reactor startup - boron concentration must be decreased from shutdown concentration to achieve criticality.

b) Load follow - boron concentration must be either increased or decreased to compensate for the xenon transient following a change in load.

c) Fuel burnup - boron concentration must be decreased to compensate for fuel burnup and the buildup of fission products in the fuel.

d) Cold shutdown - boron concentration must be increased to the cold shutdown concentration.

The Boron Thermal Regeneration System may be used to control boron concentration to compensate for xenon transients during load follow operations. Boron thermal regeneration can also be used in conjunction with dilution operations of the Reactor Makeup Control System during startup from cold shutdown to reduce the amount of effluent to be processed by the Boron Recycle 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 provided blended boric acid solution, preset to match the boron concentration in the RCS. Manual makeup may be necessary due to valve controllability limitations at very low or very high boron concentrations. Manual makeup may be performed at any boron concentration as deemed necessary. Automatic makeup compensates for minor leakage of reactor coolant without causing significant changes in the reactor coolant boron concentration.

Placing the mode selector switch for the Reactor Makeup Control System in "automatic makeup," positions the makeup stop valves for automatic makeup. The total makeup flow controller and the boric acid flow controller are set 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 continued to decrease, an emergency low level signal opens the isolation valves in the refueling water supply line to the charging pumps, and closes the isolation valves in the volume control tank outlet line.

Possible loss of suction and subsequent damage to all safety injection pumps due to failure of the volume control tank level instrumentation and level control system is discussed in Reference 9.3.4-1.

b) Dilution

The "dilute" mode of operation permits the addition of a preselected quantity of reactor makeup water at a preselected flowrate to the RCS. The operator sets the mode selector switch to "dilute", the total makeup flow controller setpoint to the desired flowrate, the total makeup batch integrator to the desired quantity and initiates system start. This opens the reactor makeup water flow control valve, opens the makeup stop valve to the 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 boron recycle system. 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.

c) Alternate Dilution

The "alternate dilute" mode of operation is similar to the dilute mode except a portion of the dilution water flows directly to the charging pump suction and a portion flows into the 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 only to the volume control tank, as is the case with the "dilute" mode of operation.

d) Boration

The "borate" mode of operation permits the addition of a preselected quantity of concentrated boric acid solution at a preselected flowrate to the RCS. The operator sets the mode selection switch to "borate", the concentrated boric acid flow controller setpoint to the desired flowrate, the concentrated boric acid batch integrator to the desired quantity, and initiates system start. This opens the makeup stop valve to the charging pumps suction, positions the boric acid flow control valve, and starts the selected boric acid transfer pump which delivers a 4 weight percent boric acid solution, which is so small in most cases 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 causes makeup to stop. Also, the operation may be terminated manually at any time.

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 recycle system, or to some other location via a temporary connection. While in the manual mode of operation, automatic makeup to the RCS is precluded. The discharge flow path must be prepared by opening manual valves in the desired path.

The operator sets the mode selector switch to "manual", the boric acid and total makeup flow controllers to the desired flowrates, the boric acid and total makeup batch integrators to the desired quantities, and actuates the makeup start switch.

The start switch actuates the boric acid flow control valve and the reactor makeup water flow control valve and starts the preselected reactor makeup water pump and boric acid transfer pump.

When the preset quantities of boric acid and reactor makeup water have been added, the batch integrators cause makeup to stop. This operation may be stopped manually by actuating the makeup stop switch.

If either batch integrator is satisfied before the other has recorded its required total, the pump and valve associated with the integrator which has been satisfied will terminate flow. The flow controlled by the other integrator will continue until that integrator is satisfied.

The quantities of boric acid and reactor makeup water injected are totalized by the batch counters and the flowrates are recorded on strip recorders. Deviation alarms sound for both boric acid and reactor makeup water if flowrates deviate from setpoints.

9.3.4.1.2.4 Boron Thermal Regeneration System

Downstream of the mixed bed demineralizers, the letdown flow can be diverted to the Boron Thermal Regeneration System where the letdown flow can be treated when boron concentration changes are desired for load follow. After processing, the flow is returned to a point upstream of the reactor coolant filter.

Grab sampling (see Section 9.3.2) can be used to monitor the boron content in the letdown stream, or the adjusted boron content of the letdown stream after it has been treated by the thermal regeneration process if the BTRS is in service.

Storage and release of boron during load follow operation is determined by the temperature of fluid entering the thermal regeneration demineralizers. A chiller unit and a group of heat exchangers can provide the desired fluid temperature at the BTRS demineralizer inlets for either storage or release operation of the system. (Note, however, that the BTRS chillers are in long-term shutdown with service water isolated to the condenser and power removed from the chilled water pump. The chillers are not needed or used for end-of-life dilution.)

The flow path through the Boron Thermal Regeneration System is different for the boron storage and the boron release operations. During boron storage (i.e., dilution operation), the letdown stream enters the moderating heat exchanger and from then 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 demineralizer, the process flow enters the moderating heat exchanger shell side, where it is used to cool the letdown stream entering the BTRS. The process flow is then directed 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 boron release (i.e., boration 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 flowrate on the tube side of the letdown reheat heat exchanger. After passing through the demineralizers, the process stream enters the shell side of the moderating heat exchanger where it is cooled by the incoming letdown stream, passes through the tube side of the letdown chiller heat exchanger for additional cooling, and is then directed to the volume control tank. The temperature of the letdown stream entering the volume control tank is controlled by automatic adjustment to the shell side flowrate 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 releases boron 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.

Although the Boron Thermal Regeneration System is sized primarily to compensate for xenon transients occurring during load follow, it can also be used to handle boron swings far in excess of the design capacity of the demineralizers. During startup dilution, for example, the resin beds are first saturated, then washed off to the Boron Recycle System, then again saturated and washed off. This operation continues until the desired dilution in the RCS is obtained. In this manner, the effluents produced by dilution (which must be processed in the Boron Recycle System) can be minimized.

As an additional function, a thermal regeneration demineralizer can be used as a deborating demineralizer, which would be used to dilute the RCS down to very low boron concentrations towards the end of a core cycle. During this evolution it is permissible to deborate without running the chillers. This will slow down the deboration process.

9.3.4.1.2.5 Component description

A summary of principal component design parameters is given in Table 9.3.4-2, and safety classifications and design codes are given in Section 3.2.

<u>Piping</u>

CVCS piping that handles radioactive liquid is austenitic stainless steel. Piping joints and connections are welded, except where flanged connections are required to facilitate equipment removal for maintenance and hydrostatic testing.

Charging Pumps

Three charging pumps of the single speed, horizontal, centrifugal type are supplied to inject coolant into the RCS. Parts in contact with the reactor coolant are fabricated of austenitic stainless steel or other corrosion resistant material. There is a minimum flow recirculation line to protect the centrifugal charging pumps from a closed discharge valve condition.

Charging flowrate is determined from a pressurizer level signal which regulates 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.

Boric Acid Transfer Pumps

Two pumps are supplied, one pump is normally aligned to supply boric acid from the boric acid tank 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 one pump to provide normal makeup of boric acid solution to the suction header of the charging pumps. Minimum flow recirculation from this pump flows back to the boric acid tank and helps maintain thermal equilibrium. The standby pump can be used intermittently to circulate boric acid solution through the boric acid tank to maintain thermal equilibrium in this part of the system. Emergency boration, which supplies 4 weight percent boric acid solution directly to the suction of the charging pumps, can be accomplished by manually starting either pump. The transfer pumps also function to transfer boric acid solution from the batching tank to the boric acid tank. The boric acid pumps are not operated in parallel, without the boric acid tank recirc line orifice bypass valve open, due to the potential to "dead-head" the weaker pump, in accordance with NRC Bulletin 88-04.

The pumps are located in a heated area to prevent crystallization of the boric acid solution. Parts in contact with the solution are of austenitic stainless steel.

Chiller Pumps

Two centrifugal pumps circulate the water through the chilled water loop in the Boron Thermal Regeneration System. One pump is normally operated, with the second serving as a standby pump.

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 and the charging stream flows through the tubes. The unit is constructed of austenitic stainless steel, and is of all welded construction.

The temperatures of both outlet streams from the heat exchanger are monitored with indication given in the Control Room. A high temperature alarm is actuated on the main control board if the temperature of the letdown stream exceeds desired limits.

Letdown Heat Exchanger

The letdown 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 component cooling water flows through the shell side. 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 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 is provided on the main control board. If the outlet temperature from the heat exchanger is excessive, a high temperature alarm is actuated and a temperature controlled valve diverts the letdown directly to the volume control tank.

Excess Letdown Heat Exchanger

The excess letdown heat exchanger cools reactor coolant letdown flow at a rate which 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. Surfaces in contact with reactor coolant are austenitic stainless steel and the shell is carbon steel.

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.

Seal Water Heat Exchanger

The seal water heat exchanger is designed to cool fluid from three sources: reactor coolant pump number 1 seal leakage, reactor coolant discharged from the excess letdown heat exchanger, and recirculation flow from a centrifugal charging pump. Reactor coolant flows through the tube side of the heat exchanger and component cooling water is circulated through the shell. The design flowrate through the tube side is equal to the sum of the nominal reactor coolant pump seal leakage, and miniflow from two centrifugal charging pumps. The unit is designed to cool the above flow to the temperature normally maintained in the volume control

tank. Surfaces in contact with reactor coolant are austenitic stainless steel and the shell is carbon steel.

The Boron Thermal Regeneration System is not used in SHNPP to adjust the RCS boron concentration to compensate for xenon transients during load follow operations. The BTRS is used towards the end of core life (RCS boron concentration < 300 ppm) at the prevailing letdown temperature to reduce the boron concentration of the reactor coolant. Consequently, the BTRS heat exchangers are no longer used as intended by the original system design. The following information that describes the original design basis of the BTRS heat exchangers is retained for historical purposes.

Moderating Heat Exchanger

The moderating heat exchanger operates as a regenerative heat exchanger between incoming and outgoing streams to and from the thermal regeneration demineralizers.

The incoming flow enters the tube side of the moderating heat exchanger. The shell side fluid, which comes directly from the demineralizers, enters at low temperature during boron storage and high temperature during boron release. The unit is constructed of austenitic stainless steel.

Letdown Chiller Heat Exchanger

During the boron storage operation, the process stream enters the tube side of the letdown chiller heat exchanger after leaving the tube side of the moderating heat exchanger. The letdown chiller heat exchanger cools the process stream to allow the thermal regeneration demineralizers to remove boron from the coolant. The desired cooling capacity is achieved by automatic control of the chilled water flowrate passed through the shell side of the heat exchanger.

The letdown chiller heat exchanger is also used during the boron release operation to cool the liquid leaving the shell side of the moderating heat exchanger to ensure that its temperature does not exceed that of normal letdown to the volume control tank. Surfaces in contact with reactor coolant are austenitic stainless steel and the shell is carbon steel.

Letdown Reheat Heat Exchanger

The letdown reheat exchanger is used only during boron release operations and it is then used to heat the process stream. 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. The unit is constructed of austenitic stainless steel.

Volume Control Tank

The volume control tank provided surge capacity for part of the reactor coolant expansion 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 Recycle System. The tank also provides a means for introducing hydrogen into the coolant to maintain the required equilibrium concentration. In addition, the tank is used for

degassing the reactor coolant and serves as a head tank for the charging pumps. The tank is constructed of austenitic stainless steel.

A spray nozzle 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 Hydrogen Storage System) is supplied to the volume control tank while a remotely operated vent valve, discharging to the Gaseous Waste Processing System, permits removal of gaseous fission products which are stripped from the reactor coolant and collected in this tank. Relief protection, gas space sampling, and nitrogen purge connections are also provided. The tank can also accept the seal water return flow from the reactor coolant pumps and the miniflow from the charging pumps through an auxiliary spray nozzle, although these flows may go directly to the suction of the charging pumps.

Volume control tank pressure is monitored with indication given in the Control Room. Alarm is actuated in the Control Room for high and low pressure conditions. The volume control tank pressure control valve is automatically closed by the low pressure signal.

Two level channels govern the water inventory in the volume control tank. Level indication with high and low alarms is provided on the main control board for one controller and local level indication 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 Recycle System and a portion to the volume control 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.

When the Reactor Makeup Control System is in the automatic mode, a low level in the volume control tank initiates automatic makeup which injects a preselected 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. Manual makeup may be necessary due to valve controllability limitations at very low or very high boron concentrations. Manual makeup may be performed at any boron concentration as deemed necessary.

If the automatic makeup fails and the tank level continues to decrease, a low level alarm is actuated. Manual action may correct the situation or, if the level continues to decrease, a low-low signal from both level channels opens the associated isolation valve in the refueling water supply line and closes the associated isolation valve in the volume control tank outlet line.

Boric Acid Tank

The 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. Periodic manual sampling and corrective action, if necessary, assure that these limits are maintained. As a consequence, measured amount of boric acid solution can be delivered to the reactor coolant to control the boron concentration.

A temperature sensor provides temperature measurement of the tank's contents. Temperature indication, as well as high and low temperature alarms, is provided on the main control board.

Two level detectors indicate the level in the 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 to satisfy the technical specification for a cold shutdown with one stuck rod. The empty level alarm is set to give warning of loss of pump suction.

Batching Tank

The batching tank is used for mixing a makeup supply for boric acid solution for transfer to the boric acid tank.

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 insure complete mixing during batching operations and a steam jacket for heating the boric acid solution.

Chemical Mixing Tank

The primary use of the chemical mixing tank is in the preparation and addition of caustic solutions for pH control and hydrazine solution for oxygen scavenging.

Chiller Surge Tank

The chiller surge tank handles the thermal expansion and contraction of the water in the chiller loop. The surge volume in the tank also acts as a thermal buffer for the chiller. Because the chillers are kept in long-term shut-down with the chilled-water loop drained, surge tank level indication is de-energized and the level alarms are de-energized with the window removed from the main control board.

Reactor Coolant Pump Standpipe

A seal standpipe provides a reservoir for seal injection water at a constant head to the reactor coolant pump number 3 double dam seal. A seal standpipe is supplied with each reactor coolant pump.

Mixed Bed Demineralizers

Two flushable, mixed bed demineralizers assist in maintaining reactor coolant purity. Normally, lithium-form cation resin and a hydroxyl-form anion resin are loaded into the demineralizers. However, during reactor shutdown prior to refueling, a fresh charge of mixed resin containing hydronium-form cation resin may be used instead of the lithium-form cation resin. In both cases, the anion resin is converted to the borate form during operation. Both types of mixed

bed formulations remove fission and corrosion products. The resin beds are designed to reduce the concentration of ionic isotopes in the purification stream, except for cesium, yttrium and molybdenum, by a minimum factor of 10.

Each demineralizer has more than sufficient capacity for one core cycle with one percent of the rated core thermal power being generated by failed fuel. One demineralizer is normally in service with the other in standby.

A temperature sensor monitors the temperature of the letdown flow downstream of a letdown heat exchanger and if the letdown temperature exceeds the maximum allowable resin operating temperature (approximately 140F), a three-way valve is automatically actuated to bypass the flow around the demineralizers. Temperature indication and high alarm are provided on the main control board. The air operated three-way valve failure mode directs flow to the volume control tank.

Cation Bed Demineralizer

A flushable demineralizer with cation resin in the hydrogen form is located downstream of the mixed bed demineralizers and is used intermittently to control the concentration of Li^7 which builds up in the coolant from the $B^{10} \rightarrow (n,\alpha) \rightarrow Li^7$ reaction. The demineralizer also has sufficient capacity to maintain the Cesium-137 concentration in the coolant below 1.0 μCi/cc with 1 percent failed 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 is sized to accommodate normal letdown flow when in service, which is more than adequate to control Li^7 or cesium in the RCS.

The demineralizer has more than sufficient capacity for one core cycle with one percent of the rated core thermal power being generated by failed fuel.

Thermal Regeneration Demineralizers

The Boron Thermal Regeneration System is not used in SHNPP to adjust the RCS boron concentration to compensate for xenon transients during load follow operations. The BTRS demineralizers are used towards the end of core life (RCS boron concentration < 300 ppm) at the prevailing letdown temperature to reduce the boron concentration of the reactor coolant. The following information that describes the original design basis of the BTRS demineralizers is retained for historical purposes.

The function of the thermal regeneration demineralizers is to store the total amount of boron that must be removed from the RCS to accomplish the required dilution during a load cycle in order to compensate for the initial transient 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 the initial transient decrease in xenon concentration resulting from an increased power level.

The thermally reversible ion storage capacity of the resin applies only to borate ions. The capacity of the resin to store other ions is not thermally reversible. Thus, during boration, when borate ions are released by the resin, there is no corresponding release of the ionic fission and corrosion products stored on the resin.

The thermal regeneration demineralizer resin capacity is directly proportional to the solution boron concentration and inversely proportional to the temperature. Further, the differences in capacity as a function of both boron concentration and temperature are reversible. For the 50F to 140F temperature cycle this reversible capacity varies from the beginning of a core cycle to the end of core life by a factor of about 2.

The demineralizers are of the type that can accept flow in either direction. The flow direction during boron storage is always opposite to that during release. This provides much faster response when the beds are switched from storage to release and vice versa, than would be the case if the demineralizers could accept flow in only one direction.

Temperature instrumentation is provided upstream of the thermal regeneration demineralizers to control the temperature of the process flow. During boron storage operations, it controls the flow through the shell side of the letdown chiller heat exchanger to maintain the process flow at 50F as it enters the demineralizers. During boron release operations, it controls the flow through the tube side of the letdown reheat heat exchanger to maintain the process flow at 140F as it enters the demineralizers. Temperature indication and a high temperature alarm are provided on the main control board.

An additional temperature instrument is provided to protect the demineralizer resins from a high temperature condition. On reaching the high temperature setpoint, an alarm is sounded on the main control board and the letdown flow is diverted to the volume control tank from a point upstream of the mixed bed demineralizers.

Failure of the temperature controls resulting in hot water flow to the demineralizers would result in a release of boron stored on the resin with a resulting increase in reactor coolant boron concentration and increased margin for shutdown. If the temperature of the resin rises significantly above 140F, the number of ion storage sites will gradually decrease, thus reducing the capability of the resin to remove boron from the process stream. Degradation of ion removal capability will occur for temperatures of approximately 160F and above. The extent of the 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.

Failure of the temperature control system resulting in cold water flow to the demineralizers would result in storage of boron on the resin and reduction of the reactor coolant boron concentration. The amount of reduction in reactor coolant boron concentration is limited by the capacity of the resin to remove boron from the water. As the boron concentration is reduced, the control rods would be driven into the core to maintain power level. If the rods were to reach the shutdown limit setpoint, an alarm would be actuated informing the operator that emergency boration of the RCS is necessary in order to maintain capability of shutting the reactor down with control rods alone.

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 flow capacity of the filter is designed to accept the maximum purification flowrate.

A differential pressure indicator is provided to show filter differential pressure. A high differential pressure alarm is provided on the BOP B/F Filter Auxiliary Control Panel.

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.

A differential pressure indicator is provided to show the pressure drop across each seal water injection filter. A high differential pressure alarm is provided on the BOP B/F Filter Auxiliary Control Panel.

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 seal leakage from all reactor coolant pumps.

A differential pressure indicator is provided to show differential pressure across the filter. A high differential pressure alarm is provided on the BOP B/F Filter Auxiliary Control Panel.

Boric Acid Filter

The boric acid filter collects particulates from the boric acid solution being pumped from the boric acid tank by the boric acid transfer pumps. The filter is designed to pass the design flow of two boric acid transfer pumps operating simultaneously.

A differential pressure indicator is provided to show the pressure drop across the boric acid filter. A high differential pressure alarm is provided on the BOP B/F Filter Auxiliary Control Panel.

Letdown Orifices

Three letdown orifices are provided to reduce the letdown pressure from reactor conditions and to control the flow of reactor coolant leaving the RCS. Each letdown orifice consists of an assembly which provides for permanent pressure loss without recovery, and is made of austenitic stainless steel or other adequate corrosion resistant material. The orifices are placed into or out of service by remote operation of their respective isolation valves. The letdown flowrate is chosen according to plant operational requirements and is adjusted by selecting the proper combination of letdown orifices. Plant operational requirements include but are not limited to RCS purification, plant heatups and shutdowns and flow control at low RCS pressures. The Chapter 15 Accident Analyses are based on a normal letdown flow of 105 gpm. Radiological dose consequence evaluations conservatively consider maximum letdown flow to be approximately 120 gpm.

A flow monitor provides indication in the control room of the letdown flowrate, and a high alarm to indicate unusually high flow.

A low pressure letdown valve located downstream of the letdown heat exchanger controls the pressure upstream of the letdown heat exchanger to prevent flashing of the letdown liquid. Pressure indication and high pressure alarm are provided on the main control board.

Number 1 Seal Bypass Orifices

An orifice in each reactor coolant pump number 1 seal bypass line is only in service during startup or shutdown when the RCS pressure is low. The bypass flow is necessary to ensure adequate flow for cooling of the pump's lower radial bearing and to limit the temperature rise of the water cooling the number 1 seal. The orifice is constructed of austenitic stainless steel and designed to pass adequate flow for the differential pressure existing at the lowest allowable RCS pressure for reactor coolant pump operation.

Boric Acid Blender

The boric acid blender, made of austenitic stainless steel, is provided to ensure thorough mixing of the 4 weight percent solution of boric acid and reactor makeup water when required. The blender is designed to pass the maximum letdown flow.

Chillers

The Boron Thermal Regeneration System is not used in SHNPP to adjust the RCS boron concentration to compensate for xenon transients during load follow operations. The BTRS is used towards the end of core life (RCS boron concentration < 300 ppm) at the prevailing letdown temperature to reduce the boron concentration of the reactor coolant. Consequently, the BTRS chiller units are no longer used as intended by the original system design. The following information that describes the original design basis of the BTRS chiller units is retained for historical purposes.

Two chillers are located in a chilled water loop containing a surge tank, chiller pumps, the letdown chiller heat exchanger, piping, valves and controls. One chiller is normally operated, with the second serving as a standby.

The purpose of the chillers is twofold:

a) Valves 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.

Where pressure and temperature conditions permit, diaphragm type valves are used to essentially eliminate leakage to the atmosphere. Packed valves which are larger than two in. and which are designated for radioactive services are provided with a stuffing box and lantern leak-off connections. Control (modulating) and three-way valves are either provided with stuffing box and leakoff connections or are totally enclosed. Leakage to the atmosphere is essentially zero for these valves. Basic material of construction is stainless steel for 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 spring loaded check valves.

b) Letdown Line Downstream of Letdown Orifices - The pressure relief valve downstream of the letdown orifices protects the 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 flowrate through all letdown orifices. The valve set pressure is equal to the design pressure of the protected portion of the system.

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 flowrate through all letdown orifices. The valve set pressure is equal to the design pressure of the protected portion of the system.

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 equal to the summation of the following items: maximum letdown, normal seal water return, excess letdown and nominal flow from one reactor makeup pump. The valve set pressure equals the design pressure of the volume control tank.

e) Charging Pump Suction - Two relief valves on the charging pump suction header relieve pressure that might 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) - This relief valve is designed to relieve overpressurization in the seal water return piping inside Containment if the motor operated isolation valve is closed. The valve is designed to relieve the total leakoff flow from the number 1 seals of the reactor coolant pumps plus the design excess letdown flow. The valve is 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 exchanger and its associated piping from overpressurization. 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 protected portion of the system.

h) Letdown Reheat Heat Exchanger - The relief valve is located on the piping leading from the shell side of the head 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.

i) Steam Line to Batching Tank - The relief valve on the steam line to the batching tank protects the low pressure piping and batching tank heating jacket from overpressure should the condensate return line be isolated. The capacity of the relief valve equals the maximum expected steam inlet flow. The set pressure equals the design pressure of the heating jacket.

9.3.4.1.2.6 System operation

Reactor Startup - Reactor startup is defined as the operations which bring the reactor from cold shutdown to normal operating temperature and pressure.

It is assumed that:

a) Normal residual heat removal is in progress.

b) RCS boron concentration is greater than or equal to the cold shutdown concentration but less than 2600 ppm.

c) Reactor Makeup Control System is set to provide makeup greater than or equal to the cold shutdown concentration.

d) RCS is either water solid or drained to minimum level for the purpose of refueling or maintenance. If the RCS is water solid, system pressure is maintained by operation of a charging pump and controlled by the low pressure letdown valve in the letdown line (letdown is achieved via the Residual Heat Removal System).

e) The charging and letdown lines of the CVCS are filled with coolant at the current RCS boron concentration. The letdown orifice isolation valves are typically open to reduce the thermal shock on the CVCS when RHR low pressure letdown is secured. There have been several events where a pressure transient was initiated from a thermal shock.

If the RCS requires filling and venting, the procedure for high pressure fill and vent or low pressure fill and vent is as follows:

a) One charging pump is started, which provides blended flow from the Reactor Makeup Control System at greater than or equal to 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.

Or,

d) Fill the RCS using vacuum fill process.

The system pressure is raised by using the charging pump and controlled by the low pressure letdown valve. 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.

After the filling and venting operations are completed, charging and letdown flows are established. All pressurizer heaters are energized and the reactor coolant pumps are employed to heatup the system. After the reactor coolant pumps are started, pressure control via the Residual Heat Removal System (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 RHR low pressure letdown flow is gradually secured and the RHR system is isolated from the RCS. The CVCS letdown path becomes the primary letdown path and the pressurizer heaters are used to increase RCS pressure.

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. During heatup, the appropriate combination of letdown orifices is used to provide necessary letdown flow.

The reactor coolant boron concentration may now be reduced by operating the Reactor Makeup Control System in the "dilute" mode. The reactor coolant boron concentration is adjusted to the point where the control rods may be withdrawn and criticality achieved or the control rods are positioned to a target rod height and criticality is achieved by dilution.

Power ascension may then proceed with corresponding manual adjustment of the reactor coolant boron concentration to balance temperature coefficient effects and maintain the control rods within their operating range.

<u>Power Generation and Hot Standby Operation</u>

1) Base Load - At a constant power level, the rates of charging and letdown are dictated by the requirements for seal water to the reactor coolant pumps and the normal purification of the RCS. One charging pump is employed and charging flow is controlled automatically from pressurizer level. The only adjustments in boron concentration necessary are those to compensate for core burnup. These adjustments are made whenever necessary to maintain the rod control groups at the desired rod height. 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 mixed bed demineralizer is in service. Reactor coolant samples are taken periodically to check boron concentration, water quality, pH and activity level. The charging flow to the RCS is controlled automatically by the pressurizer level control signal through the discharge header flow control valve.

2) Load Follow - A power reduction will initially cause a xenon buildup followed by xenon decay to a new lower equilibrium value. The reverse occurs if the power level increases; initially, the xenon level decreases and then it increases to a new and higher equilibrium value associated with the amount of the power level change.

The Reactor Makeup Control System is normally used to vary the boron concentration in the reactor coolant to compensate for xenon transients occurring when reactor power level is changed.

The most important information 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 stored. During this period, the flow through the letdown orifice remains constant and the charging flow is reduced by the pressurizer level control signal, resulting in an increased temperature at the regenerative 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.

3) Hot Standby - If required, for periods of maintenance, or following spurious reactor trips, the reactor can be held subcritical, but with the capability to return to power within the period of time it takes to withdraw control rods for a reactor start up. During this hot standby 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 concentration and all control rods inserted, the core is maintained at a minimum of 1 percent subcritical ($k_{eff} < 0.99$). Initially the effect of xenon buildup is to increase this value to a maximum of about 4 percent ($k_{eff} < 0.96$) at about eight hours following shutdown from equilibrium full power conditions. The negative reactivity associated with xenon then begins to decay and decreases to approximately its preshutdown worth at about 24 hours. If hot standby is maintained past this point, xenon decay results in a decrease in degree of shutdown. Since the reactivity worth of 100% equilibrium xenon concentration is about 3 percent assuming that an equilibrium concentration had been reached during operation, boration of the reactor coolant is necessary to counteract the xenon decay to maintain shutdown.

   If a rapid reactor startup is anticipated, dilution of the system may be performed to counteract this initial xenon buildup. However, after the xenon concentration decays to less than its preshutdown reactivity worth, boration must be performed to maintain the reactor subcritical as the xenon decays out.

4) 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 ($k_{eff} < 0.99$) and $T_{avg} \leq 200°F$).

   Xenon Free Cold Shutdown - The boron concentration required to maintain shutdown margin with $T_{avg} \leq 200°F$ without taking credit for the negative reactivity associated with xenon. This condition is an additional requirement prior to securing reactor coolant pumps or cooling down without computer program to calculate the negative reactivity associated with xenon versus time.

   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.

   Before cooldown and depressurization of the reactor plant is initiated, the previous core history is modeled in a three dimensional nodal simulator and the required RCS boron concentration as a function of time for various reactor coolant temperatures is determined. The operator can then select a plan of action that establishes the required boron concentration for a particular temperature prior to reaching the temperature. Periodic boron samples and temperature logs verify compliance with shutdown margin requirements. At least one of the RCPs will remain in service until boron samples of RCS verify that the xenon free cold shutdown margin is achieved. If the nodal simulator is unavailable, or if a suitable plan cannot be developed, it is always acceptable to borate to the cold shutdown value prior to initiating the cooldown. In either case 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 system contraction at the shutdown reactor coolant boron concentration.

   Contraction of the coolant during cooldown of the RCS results in actuation of the pressurizer level control to maintain normal pressurizer water level. The charging flow is increased, relative to letdown flow, and results in a decreasing volume control tank level. The volume control tank level controller automatically initiates makeup to maintain the inventory when the Reactor Makeup Control System is in the automatic mode.

   After the RHRS is placed in service and the reactor coolant pumps are shutdown, further cooling of the pressurizer liquid is accomplished by charging through the auxiliary spray line. Coincident with plant cooldown, a portion of the reactor coolant flow is diverted from the RHRS to the CVCS for cleanup. Demineralization of ionic radioactive impurities and stripping of fission gases reduce the reactor coolant activity level sufficiently to permit personnel access for refueling or maintenance operations.

9.3.4.1.3 Safety evaluation

The classification of structures, components and systems is presented in Section 3.2. A further discussion on seismic design categories is given in Section 3.7. Conformance with 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. See Section 8.3.1.1.2.4 for additional information on electrical connections, interlocks, and alarms.

9.3.4.1.3.1 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 the normal cold shutdown assuming that the control assembly of greatest worth is in its fully withdrawn position. This quantity always exceeds the quantity of boric acid required to bring the reactor to hot shutdown and to compensate for subsequent xenon decay. An adequate quantity of boric acid is also available in the 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 minimum rate of boration, with a single boric acid transfer pump operating, is sufficient to take the reactor from full power operation to 1 percent shutdown in the hot condition, with no rods inserted, in less than 6 hours. Likewise, the conservatively low rate of boration presented in Technical Specifications is more than sufficient to maintain this shutdown condition by compensating (in advance) for eventual xenon decay. Additional boric acid is employed if it is desired to bring the reactor to cold shutdown conditions.

Two separate and independent flow paths are available for reactor coolant boration; i.e., the charging line and the reactor coolant pump seal injection line. Solution temperature requirements are maintained. A single failure does not result in the inability to borate the RCS.

If the normal charging line is not available, charging to the RCS is continued via reactor coolant pump seal injection at the rate of approximately 5 gpm per pump. At the charging rate of 15 gpm (5 gpm per reactor coolant pump), approximately 3.5 hours are required to add enough boric acid solution to counteract xenon decay, although xenon decay below the full power equilibrium operating level will not begin until approximately 25 hours after the reactor is shut down.

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, operating procedures require immediate action to effect repairs of an inoperable component, restrict permissible repair time, and require demonstration of the operability of the redundant component.

9.3.4.1.3.2 Reactor coolant purification

The CVCS is capable of reducing the concentration of ionic isotopes in the purification stream as required in the design basis. This is accomplished by passing the letdown flow through one of the mixed bed demineralizers which removed 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 μ Ci/cc, assuming one-percent of the rated core thermal power is being produced by fuel with defective cladding. The cation bed demineralizer is capable of passing the normal letdown flow,

though only a portion of this capacity is normally utilized. Each mixed bed demineralizer is capable of processing the maximum purification letdown flowrate. If the normally operating mixed bed demineralizer's resin has become exhausted, the second demineralizer can be placed in service. Each demineralizer is designed, however, to operate for one core cycle with one percent failed 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 the 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. 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 reaches 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 take place (at a faster rate) when temperature is increased. However, with increasing temperature, the resin loses some of its ion exchange sites along with the ions that are held at the lost sites. The ions lost from the sites may be re-exchanged farther down the bed. The number of sites lost is a function of the temperature reached in the bed and of the time the bed remains at the high temperature. Capability for ion exchange will not be lost until a significant portion of the exchange sites are lost from the resin.

There would be no safety problem associated with over-heating of the demineralizer resins. The only effect on reactor operating conditions would be the possibility of an increase in the reactor coolant activity level. If the activity level in the reactor coolant were to exceed the limit given in the Technical Specifications, reactor operation would be restricted as required by the Technical Specifications.

9.3.4.1.3.3 Seal water injection

Flow to the reactor coolant pumps' seals is assured by the fact that there are three charging pumps, any one of which is capable of supplying the normal charging line flow plus the nominal seal water flow.

9.3.4.1.3.4 Hydrostatic testing of the reactor coolant system

The charging pump discharge header incorporates a hydrostatic test connection which can be used to perform this test. The hydro test pump which is located in the Safety Injection System is utilized to pressurize the RCS to its maximum specified hydrostatic test pressure.

9.3.4.1.3.5 Leakage provisions

CVCS components, valves, and piping used 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 are used to essentially eliminate leakage to the atmosphere.

2. All packed valves which are larger than 2 in. 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 are provided to facilitate maintenance and hydrostatic testing.

The volume control tank provides an 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 in the volume control tank are purged to the Waste Processing System, to limit the release of radioactive gases through leakage. Purging maintains the radioactive gas concentration in the reactor coolant significantly lower than the limits required by the Technical Specifications. Also provided are two mixed bed demineralizers which maintain reactor coolant purity, thus reducing the radioactivity level of the RCS water.

9.3.4.1.3.6 Ability to Meet the Safeguards Function

A failure analysis of the portion of the CVCS which is safety-related (used as part of the Emergency Core Cooling System) is included as part of the emergency core cooling system failure analyses presented in Tables 6.3.1-1 and 6.3.2-5.

9.3.4.1.3.7 Heat Tracing

Heat tracing requirements for boric acid solutions depends mainly on the solution concentration. The concentration of boric acid in the CVCS ranges from 10 ppm to 4 weight percent 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 65F or higher. Redundant temperature alarms are provided to assure room temperature does not go below 65F. Refer to Section 9.3.4.1.2 for more information.

9.3.4.1.3.8 Abnormal Operation

The CVCS is capable of making up for a RCS leak up to approximately 130 gpm using one centrifugal charging pump and still maintaining seal injection flow to the reactor coolant pumps. This also allows for a minimum RCS cooldown contraction. This is accomplished with the letdown isolated.

9.3.4.1.4 Inspection and Testing Requirements

The CVCS will undergo preoperational and startup test as described in Section 14.2.12.

Inservice inspection will be performed in accordance with Section 6.6, and the pump and valve testing requirements of Section 3.9.6 will apply.

As part of plant operation, periodic tests, surveillance inspections and instrument calibrations are made to monitor equipment condition and performance. Most components are in use regularly; therefore, assurance of the availability and performance of the systems and equipment is provided by Control Room and/or local indication.

Technical Specifications (Chapter 16) have been established concerning calibration checking, and sampling of the CVCS.

9.3.4.1.5 Instrumentation Requirements

Process control instrumentation is provided to acquire data concerning key parameters about the CVCS. The location of the instrumentation is shown on Figures 9.3.4-1 through 9.3.4-5.

The instrumentation furnishes input signals for monitoring and/or alarming purposes. Indications and/or alarms are provided for the following parameters:

a) Temperature

b) Pressure

c) Flow

d) Water level

The instrumentation also supplies input signals for control purposes. Some specific control functions are:

a) Letdown flow is diverted to the volume control tank upon high temperature indication upstream of the mixed bed demineralizers.

b) Pressure upstream of the letdown heat exchanger is controlled to prevent flashing of the letdown liquid.

c) Charging flowrate is controlled during charging pump operation.

d) Water level and pressure are controlled in the volume control tank.

e) Temperature of the boric acid solution in the batching tank is maintained.

f) Reactor makeup and boron concentration are controlled.

g) Temperature of letdown flow to the Boron Thermal Regeneration System is controlled.

h) Chilled water flow to the letdown chiller heat exchanger is controlled.

i) Temperature of letdown flow return from the boron thermal regeneration demineralizers is controlled.

j) Temperature of letdown flow exiting from the letdown heat exchanger is used to control the flow of component cooling water through the heat exchanger.

k) Pressure at the outlet from the excess letdown heat exchanger is controlled so that this pressure does not exceed the allowable back pressure on the reactor coolant pump No. 1 seals.

l) Water levels in the reactor coolant pump standpipes are controlled.

9.3.4.2 Boron Recycle System

The Boron Recycle System (BRS) receives and recycles reactor coolant effluent for the purpose of recycling it as boric acid and makeup water. The system decontaminates the effluent by means of demineralization and gas stripping, and uses evaporation to separate and recover the boric acid and makeup water.

9.3.4.2.1 Design bases

9.3.4.2.1.1 Collection requirements

The BRS collects and processes effluent which can be readily reused as makeup to the Reactor Coolant System (RCS), and for water management purposes as makeup to the spent fuel pools. For the most part, this effluent is the deaerated, tritiated, borated, and radioactive water from the letdown and process drains.

The BRS is designed to collect, via the letdown line in the Chemical and Volume Control System (CVCS), the excess reactor coolant that results from the following plant operations during one core cycle:

1) Dilution for core burnup from beginning to the end of the core cycle.

2) Hot shutdowns and startups. Four hot shutdowns are assumed to take place during an annual core cycle.

3) Cold shutdowns and startups. Three cold shutdowns are assumed to take place during an annual core cycle.

4) Refueling shutdown and startup.

The BRS also collects water from the following sources:

1) Reactor coolant drain tank (Liquid Waste Processing System) - collects leakoff type drains from equipment inside the Containment (primarily RCP seal leakage).

2) Volume control tank and charging pump suction pressure reliefs (CVCS) and residual heat removal pumps pressure reliefs (Emergency Core Cooling System).

3) Boric acid blender (CVCS) - provides a transfer path if a boric acid tank must be emptied for maintenance. The boric acid solution is stored in a recycle holdup tank after first

being diluted with reactor makeup water by the blender to ensure against precipitation of the boric acid in the unheated recycle holdup tank.

4) Spent fuel pool pumps (Spent Fuel Pool Cooling and Cleanup System) - provides a transfer path to the RWST and BRS holdup tanks for the transfer canal water in case maintenance is required on the transfer equipment.

5) Valve leakoffs and equipment drains.

6) Safety Injection System - accepts flush water when boron injection tank valves are being tested or flushed.

9.3.4.2.1.2 Capacity requirement

The BRS is designed to process the total volume of water collected during a core cycle as well as short term surges. The design surge is that produced by a cold shutdown and subsequent startup during the latter part of a core cycle.

9.3.4.2.1.3 Purification requirement

The water collected by the BRS contains dissolved gases, boric acid, and suspended solids. Based on reactor operations with one percent of the rated core thermal power being generated by fuel elements with defective cladding, the BRS is designed to provide sufficient cleanup of the water to satisfy the chemistry requirements of the recycled reactor makeup water and 4 weight percent boric acid solution.

The maximum radioactivity concentration buildup in the BRS components is based on operation of the reactor at its engineered safeguards design rating with defective fuel rods generating one percent of the rated core thermal power. For each component, the shielding design considers the maximum buildup on an isotopic basis including only those isotopes which are present in significant amounts. Filtration, demineralization, and evaporation are the means by which the activity concentrations are controlled.

9.3.4.2.2 System description

The BRS is shown on Figures 9.3.4-6 and 9.3.4-7 (piping and instrumentation diagrams). When water is directed to the BRS, the flow passes first through the recycle evaporator feed demineralizers and filter and then into the recycle holdup tank.

The Recycle Evaporator is not used in SHNPP to process recycled reactor coolant effluents. The Waste Evaporator is functionally equivalent to the Recycle Evaporator and is used for this purpose by means of interconnection piping between the BRS and LWPS.

When sufficient water is accumulated to warrant evaporator operation, the recycle evaporator feed pumps take suction from the recycle holdup tank. The fluid is pumped through the recycle evaporator or a waste evaporator where dissolved gases (i.e., hydrogen, fission gases and other gases) are removed in the stripping column before the liquid enters the evaporator shell. These gases are directed to the Gaseous Waste Processing System as shown on Figures 9.3.4-6, 11.3.2-1, and 11.3.2-2.

During the operation of the evaporator, condensate (distillate) is continuously sent to the recycle monitor tanks via the recycle evaporator condensate demineralizer or to the waste evaporator condensate tank through the waste evaporator condensate demineralizer for release to the environment. From the recycle monitor tank, it can be sent to the reactor make-up tanks when needed for makeup or to the WPS monitor tanks. The condensate is monitored and is automatically diverted to the Boron Recycle Hold-up Tank for reprocessing upon detection of high activity.

The recycle evaporator concentrates the boric acid solution until a 4 weight percent solution is obtained. The accumulated batch is normally transferred directly to the boric acid tank in the CVCS through the recycle evaporator concentrates filter. Before transferring the boric acid from the evaporator to the boric acid tank, it is analyzed, and, if it does not meet the required chemical standards, it can be diverted back to the recycle holdup tank for reprocessing or to the Liquid Waste Processing System for disposal.

Connections are provided so that, if necessary, a waste evaporator can be used as a recycle evaporator.

Portions of the BRS which contain concentrated boric acid solution are located within a heated area in order to maintain solution temperature at ≥ 65F. This is 10F above the solubility limit for the nominal 4 weight percent boric acid solution. 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 ≥ 65F.

Heat tracing with temperature monitoring will be installed for the concentrates line from the recycle evaporator to the boric acid tank. The temperature will be maintained ≥ 65F for all operating modes (1-6). A combination of space heaters and heat tracing will be used for other lines carrying 4 percent wt. boric acid. The temperature monitoring for the lines with dedicated heat tracing will be the same type as stated above for the concentrates line. For the areas in which space heaters will be used, automatic temperature monitoring (area thermocouples) will be used to insure that the space heaters are started at a low setpoint temperature of 70 F. This will be for modes 1-6.

9.3.4.2.2.1 Component description

A summary of principal component data is given in Table 9.3.4-3. The codes and standards to which the individual components of the BRS are designed are listed in Section 3.2.

Piping

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.

Recycle Evaporation Feed Pumps

Two centrifugal pumps supply feed to the recycle evaporator package from the recycle holdup tank. The pumps can also be used to recirculate water from the recycle holdup tank through the recycle evaporator feed demineralizers for cleanup if desired. An auxiliary discharge connection is provided for makeup water to the fuel transfer canal from the recycle holdup tank. Another

auxiliary discharge connection is provided to supply water to the suction of the charging pumps (CVCS) for refilling the RCS after loop or system drain.

Recycle Holdup Tank

One recycle holdup tank provides storage of radioactive fluid which is discharged from the RCS during startup, shutdown, load changes and boron dilution. The sizing criteria for the tank is based on the design surge that is produced by a cold shutdown and subsequent startup during the latter part of a core cycle. The tank is constructed of austenitic stainless steel.

The tank has a diaphragm designed to prevent air from dissolving in the water and prevents the hydrogen and fission gases in the water from mixing with the air. The volume in the tank above the diaphragm is continuously ventilated with building supply air which is exhausted to the plant vent whose effluent is monitored as discussed in Section 11.5.2. Provisions are made to periodically vent any gas which might collect below the diaphragm to the Gaseous Waste Processing System as shown on Figures 9.3.4-6, 11.3.2-1, and 11.3.2-2. The Recycle Holdup Tank (RHT) gas space under the diaphragm is subject to air leakage. If an explosive gas mixture is detected by sampling under the RHT diaphragm, the gas space may be vented to the Gaseous Waste Processing System (GWPS) as needed until the gas concentration is reduced to less than 4% hydrogen or less than 4% oxygen by volume or the RHT isolation valve trips shut. The GWPS has radiation monitoring and any effluent releases via the plant vent are monitored by radiation monitor REM-1AV-3509SA.

In addition to the collection of effluents, the recycle holdup tank provides the following functions:

1. Serve as a head tank for the recycle evaporator feed pumps.

2. Provide holdup for draining the RCS to the centerline of the reactor vessel nozzles, including the pressurizer and steam generators.

3. Provide storage for fuel transfer canal water during refueling equipment maintenance, as well as an alternate makeup source to the spent fuel pools.

4. Collect discharge from the various relief valves which bypass the recycle evaporator feed demineralizers.

Recycle Evaporator Reagent Tank

This tank provides a means of adding chemicals to the evaporator; e.g., for cleanup.

Recycle Evaporator Feed Demineralizers

Two flushable, mixed bed demineralizers remove fission products from the fluid directed to the recycle holdup tanks. The demineralizers also provide a means of cleaning the recycle holdup tank contents via recirculation if necessary.

Recycle Evaporator Condensate Demineralizers

Two flushable demineralizers are provided as polishing demineralizers for distillate from the recycle evaporators. One demineralizer is normally operated, with the second serving as a

standby. Although the beds may become saturated with boron at the normally low concentration (<10 ppm) leaving the evaporator, they will still remove boron if the concentration increases because of an evaporator upset. The demineralizers also provide a means of cleanup of the reactor makeup water storage tank contents.

Recycle Evaporator Feed Filter

The filter collects resin fines and particulates from the fluid entering the recycle holdup tank.

Recycle Evaporator Condensate Filter

The filter collects resin fines and particulates from the boric acid evaporator condensate stream.

Recycle Evaporator Concentrates Filter

The filter removes particulates from the evaporator concentrate as it leaves the evaporator.

Recycle Evaporator Package

The recycle evaporator package processes dilute boric acid and produces distillate and approximately 4 weight percent boric acid stripped of hydrogen, radioactive gases, and other dissolved gases.

The recycle evaporator does not have heat tracing from the concentrates line to the boric acid tank. Processing procedures dictate that the maximum concentration of boric acid after evaporation processing is to be 4 percent weight boric acid solution. Boric acid solution will not crystallize at ambient temperatures (minimum building temperature will 50°F) unless the concentration reaches approximately 12 percent weight.

A boric acid solution is fed from the recycle holdup tank to the evaporator by the recycle evaporator feed pumps. The feed first passes through a heat exchanger where condensing steam raises its temperature.

The feed then passes into the top of the stripping column. Gases are stripped off as the feed passes over the packing in the tower in counter flow to stripping steam from the evaporator. After stripping, the feed is introduced into the evaporator as makeup. The vapors leaving the concentration section are condensed in the condenser section and pumped from the system. When the desired concentration is reached in the concentration section, the concentrates are pumped from the system.

Radioactive gases, hydrogen, and other noncondensables are discharged from the system into the waste gas vent header as shown on Figures 9.3.4-7, 11.3.2-1, and 11.3.2-2.

The recycle and waste evaporators are similar units and are interconnected so that the waste evaporators can serve as standbys for the recycle evaporator.

Recycle Holdup Tank Vent Ejector

The ejector is designed to pull gases from under the diaphragm in a recycle holdup tank and deliver them to the Gaseous Waste Processing System. Nitrogen, provided by the standby waste gas compressor, provides the motive force.

Valves

The basic material of construction for most valves is stainless steel. All valves are welded to the piping except the three-way and relief valves, which are flanged. All three-way valves are provided with a stuffing box and lantern leakoff connections. The relief valve upstream of the recycle evaporator feed demineralizers protects the piping which feeds these demineralizers.

9.3.4.2.2.2 System operation

The BRS is manually operated with the exception of a few automatic protection functions. These automatic functions protect the recycle evaporator feed demineralizers from a high inlet temperature and a high differential pressure, prevent a high vacuum from being drawn on the recycle holdup tank diaphragm, protect the recycle evaporator feed pumps from low net positive suction head, and prevent high activity recycle evaporator condensate from being sent to the reactor makeup water storage tank. The BRS has sufficient instrumentation readouts and alarms to provide the operator information to assure proper system operation.

Evaporation

Water is accumulated in the recycle holdup tank until sufficient quantity exists to warrant an evaporator startup. Prior to startup of the evaporator, the contents of the recycle holdup tank are analyzed and, if necessary, are recirculated through the recycle evaporator feed demineralizers and filter. The flow can be discharged back to the recycle holdup tank or to the evaporator. The evaporator is then operated to produce a batch of 4 weight percent boric acid.

During the operation of the evaporator, condensate can be sent to the Recycle Monitor Tank via the recycle evaporator condensate demineralizer. The condensate is routed to the waste evaporator condensate tank for release from the station.

After a batch of boric acid is concentrated to 4 weight percent, it is analyzed to ensure that it is within specifications for reuse. If it meets the specifications, it is pumped to the boric acid tank. If it does not, it can be returned to the recycle holdup tank via the recycle evaporator feed demineralizers for re-evaporation or, if desired, the concentrated boric acid can be sent to the Liquid Waste Processing System for disposal.

Recycle Holdup Tank Venting

Because hydrogen is dissolved in the reactor coolant at approximately one atmosphere overpressure, a portion of the hydrogen along with fission gases will come out of solution in the recycle holdup tank under the diaphragm. The hydrogen and fission gases are vented to the Gaseous Waste Processing System as required. The total integrated flow from the letdown line and the reactor coolant drain tank to the recycle holdup tank is monitored. The recycle holdup tank can be vented before and after a RCS loop drain or a drain from the Spent Fuel Pool Cooling and Cleanup System (or fuel transfer canal).

When venting of recycle holdup tank is required, the following steps are observed:

1) The standby waste gas compressor is lined up to the recycle holdup tank vent ejector. The standby compressor will feed the other waste gas compressor which is lined up to a catalytic recombiner and high activity gas decay tank.

2) The standby gas compressor is started up and the vent from the holdup tank is opened. The vent flow is throttled to approximately 1 scfm. At this time, a sample of the vent gases can be taken to check the composition.

3) When the gases have been vented from the recycle holdup tank, the pressure in the vent line decreases, which automatically trips the recycle holdup tank vent isolation valve closed.

4) After the vent isolation valve closes, the manual vent valve is closed and the standby gas compressor is shut down.

Maintenance Drains

When large amounts of water must be drained from the RCS or the spent fuel pool (or fuel transfer canal) to the BRS, the recycle holdup tank may be drained of water and vented to the Gaseous Waste Processing System. The water can then be stored in the tank until maintenance is completed and, after checking the chemistry, returned. After returning the water, the recycle holdup tank may again be vented to the Gaseous Waste Processing System.

Reactor Makeup Water Cleanup

If the reactor makeup water requires purification, it can be recirculated through the recycle evaporator condensate demineralizer until its chemistry is within specifications. If further processing is necessary, water from the reactor makeup water storage tank can be directed through the recycle evaporator condensate demineralizer and into the recycle holdup tank for re-evaporation.

Boric Acid Storage in the Recycle Monitor Tanks

The BRS Recycle Monitor Tanks may also be used to store boric acid solution. This additional volume of boric acid can be used during outages to promptly restore the CVCS Boric Acid Tank back to the minimum level requirement. The boric acid solution can be mixed and sampled within each recycle monitor tank to help achieve the required solution concentration before it is transferred to the BAT.

As the BRS Recycle Monitor Tanks are not heat traced or located in dedicated heated rooms, temporary heaters can be used, as necessary, to maintain the tanks above the solubility temperature of the boric acid solution.

Fuel Pool Makeup

To facilitate recycling and water management capability, water stored in the recycle holdup tank can be used as makeup water for the spent fuel pools. Administrative chemistry controls are

provided to ensure makeup is within specifications and does not cause the pools to exceed the activity limits specified in Table 11.1-7-1.

9.3.4.2.3 Safety evaluation

Malfunctions in the BRS do not affect the safety of station operations. The BRS is designed to tolerate equipment faults. Because of the large surge capacity of the BRS, the non-availability of the recycle evaporator can be tolerated for periods of time. Backup is provided by the waste evaporator.

A failure of the RHT diaphragm includes air leakage. This air leakage does not affect the safety of station operations based on design features that allow for venting both below and above the diaphragm. The radiological consequences are negligible and the station can meet the limits set forth in 10 CFR 20 and 10 CFR 50 Appendix I with air leakage.

9.3.4.2.4 Inspection and testing requirements

The BRS is in intermittent use throughout normal reactor operation. Periodic visual inspection and preventive maintenance are conducted using normal industry practice. Refer to Chapter 14.0 for further information.

9.3.4.2.5 Instrumentation requirements

Instrumentation is provided to acquire data concerning key parameters about the BRS. The location of the instrumentation is shown on Figures 9.3.4-6 and 9.3.4-7.

The instrumentation furnishes input signals for monitoring and/or alarming purposes. Indications and/or alarms are provided for the following parameters:

a) Temperature

b) Pressure

c) Flow

d) Water level

The instrumentation also supplies input signals for control purposes. Some specific control functions are:

a) Instrumentation is provided to measure the temperature of the inlet flow to the recycle evaporator feed demineralizers and to control a three-way bypass valve to bypass the demineralizers.

b) Instrumentation is provided to measure the pressure differential across the recycle evaporator feed demineralizers and to control the same three-way valve as discussed above (but independently of the temperature control) and to divert flow directly to the recycle evaporator feed filters.

c) Instrumentation is provided to measure the pressure in the recycle holdup tank vent line and to control a shutoff valve in the vent line. When the pressure in this line becomes too low during the venting, the valve will be automatically closed to protect the holdup tank diaphragm from an excessive differential pressure across it.

d) Instrumentation is provided to monitor the total integrated flow received by the BRS from the letdown line (CVCS) and the reactor coolant drain tank (Waste Processing System). Actuation of the high alarm indicates that the integrated flow has reached a value at which the volume of gases (hydrogen and fission gases) which have come out of solution should be vented from the recycle holdup tank.

e) Instrumentation is provided to give an indication of the water level of the recycle holdup tank and to stop the recycle evaporator feed pumps on low level.

f) Instrumentation is provided to give an indication of the radiation level in the recycle evaporator condensate and to cause a three-way valve to divert flow back to the recycle evaporator feed demineralizers.

9.3.4.3 Failure Mode and Effects Analysis

The failure mode and effects analysis (FMEA) summarized in Table 9.3.4-4 demonstrates that single active 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 redundancy, 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 Chapter 6.3.

9.3.5 STANDBY LIQUID CONTROL SYSTEM (BWRS)

Since SHNPP is a pressurized water reactor, this section is not applicable.

9.3.6 FAILED FUEL DETECTION SYSTEM

9.3.6.1 Design Bases

The gross failed fuel detection system consists of equipment designed to detect gross fuel failure by the measurement of delayed neutron activity in the reactor coolant.

9.3.6.2 System Description

The gross failed fuel detector is connected to the hot legs of loops 2 and 3 of the primary coolant loop (figure 9.3.2-1). The coolant sample passes through a cooler and then into a coil containing a neutron detector and moderator, after which it flows back into the volume control tank. The sample delay time to the neutron detector is adjusted by means of a flow controller. The delay time also depends on the length of tubing used. Once set, the flow is kept relatively

constant by the automatic flow control valve. A transmitting flowmeter is installed for periodic checks of the flowrate. A sensor monitors the temperature within the neutron coil.

A decay time greater than 28 seconds will be maintained for the GFFD sample prior to leaving containment. The GFFD and the primary sampling system share a common reactor coolant loop sample path inside containment and parallel outside containment. Anticipated sample flow rate is 0.63 gpm.

Figure 9.3.6-1 shows the block diagram of the gross failed fuel detector channel. The detector, preamplifier, sample cooler, and associated flow controls are located outside the containment. The signal processing equipment and readout are mounted in a rack located in the control room. The delayed neutron signal of the detector is displayed on a recorder located in the rack. The response time for the gross failed fuel detector is on the order of 60 seconds.

9.3.6.3 Safety Evaluation

The gross failed fuel detection system does not perform a safety-related function; however, it is relied on to make Emergency Preparedness Classification determinations. As shown in Figure 9.3.2-1, the gross failed fuel detector is outside the containment and is parallel with the primary coolant hot leg sample line. It is isolated from the containment by means of the sample system isolation valves. The safety evaluation of the sampling system, including the isolation valves, is discussed in Section 9.3.2.

9.3.6.4 Tests and Inspection

The gross failed fuel detection system is equipped with a test oscillator in the preamplifier and a test oscillator in the electronics drawer, each of which can be used to test the proper operation of the signal processing circuitry. Routine tests and inspections will be performed in accordance with procedures described in Section 13.5.

9.3.6.5 Instrument Applications

Instrumentation associated with the gross failed fuel detection system is described in Section 9.3.6.2.

9.3.7 HYDROGEN GAS SYSTEM

9.3.7.1 Design Basis

The Hydrogen Gas system is a non-safety system designed to applicable industry standards in order to assure its capability to meet the following functional requirements:

a) Supply the plant main generator with sufficient hydrogen gas for generator rotor and stator cooling;

b) Maintain hydrogen gas pressure in the generator at specified values assuring continuous, safe generator cooling;

c) Dry the hydrogen gas and remove any liquids entering the generator from the rotor shaft gland seal oil system or hydrogen coolers;

d) Provide continuous indication of the generator hydrogen gas pressures temperature and purity to the plant operator;

e) Provide an alarm upon sensing liquid in the generator stator.

f) Provide for removal of hydrogen gas from the generator by purging with carbon dioxide;

g) Supply hydrogen gas to the volume control tank.

h) Supply hydrogen gas to the WPB Laboratories.

9.3.7.2 System Description

Hydrogen gas is supplied to the non-safety generator cooling system and volume control tank as shown on Figure 10.2.2-5.

The CVCS volume control tank is supplied with hydrogen gas during normal power operation to control and scavenge oxygen from reactor coolant. See Section 9.3.4.1.2.2 and Figure 9.3.4-3 for details.

The main generator is a hydrogen inner-cooled unit utilizing hydrogen gas as the coolant. The hydrogen gas for charging and replenishing the generator is supplied from a central gas storage facility located in the yard as shown on Figure 1.2.2.-2. Carbon dioxide, which is used for purging hydrogen gas, is also located in the central gas storage facility as shown on Figure 1.2.2-2. The central gas storage facility has a 1500-gallon bulk liquid hydrogen cryogenic storage tank equivalent to 170,000 scf of hydrogen. The tank is a double tank designed, fabricated, and tested in accordance with the ASME Code for Unfired Pressure Vessels, Section VIII. The inner tank is stainless steel and the outer tank is carbon steel. Tank design pressure is 150 psig with an operating pressure of 135 psig. The tank has piping, regulators, valving, rupture discs, and explosion proof instruments for system control and safety. Vented gas is discharged through a 15 ft. 10 in. high stack which assures atmospheric dispersion with no local pocketing. The tank hydrogen control system includes CO_2 fire suppression provisions.

Liquid hydrogen is fed from the storage tank to ambient vaporizers, then to a manifold with valving that delivers hydrogen gas at 120 psig, and 200 scfm.

The hydrogen gas system consists of the necessary piping, valves, pressure gauges, regulators, coolers, hydrogen seal oil unit, hydrogen and carbon dioxide pressure control stations, turbine-generator hydrogen control panel, gas dryer, and other ancillary equipment. The hydrogen seal oil unit, pressure control station, hydrogen control panel, and gas dryer are located in the turbine building (elevation 261 feet) as shown on Figures 1.2.2-64 and 1.2.2-76. Piping from the gas storage facility to the turbine building is shown on Figure 10.2.2-5. The hydrogen and carbon dioxide system with interconnecting piping and valving is shown on Figure 10.2.2-6. Removal of heat from the hydrogen is via coolers served by the non-nuclear safety portion of the service water system as shown on Figure 9.2.1-2.

Hydrogen gas system pressure is controlled by manually adjustable pressure regulators and valving.

The hydrogen seal oil unit shown on Figures 1.2.2-64 and 1.2.2-76 provides oil for gland seals on the generator rotor shaft for a gas-tight enclosure to prevent the escape of hydrogen cooling gas along the generator shaft.

Hydrogen gas is routed to the hydrogen pressure control station from the hydrogen gas storage facility where it is introduced to the generator gas system. The gas is distributed uniformly to the various compartments of the generator by means of perforated pipe manifolds located in the top of the generator housing.

9.3.7.3 Purging of the Generator Cooling System

Introduction of carbon dioxide for hydrogen gas purging is via the hydrogen gas pipe manifolds. The carbon dioxide is supplied from the gas storage facility and introduced into the generator cooling system via the carbon dioxide pressure control panel. Carbon dioxide is introduced at the bottom of the generator housing via the pipe manifold, as a scavenging gas and to purge the lighter hydrogen gas out through the top gas cooling pipe manifold. The purge hydrogen gas is routed via piping to a vent external to the turbine building. The vent is appropriately located away from personnel and any ignition source. The carbon dioxide purge operation is conducted when the system is at a standstill or on turning gear. Sufficient carbon dioxide is introduced to replace the hydrogen in the generator. The hydrogen content of the gas mixture will be purged to less than 4 percent. At least two volumes (two purges of the generator) are required for sufficient scavenging. For the purging operation, a temporary purity meter is connected in parallel with the installed hydrogen purity meter. The temporary meter is designed to be more accurate than the installed hydrogen purity meter. This increases personnel safety during the purging operation and ensures an acceptable purging indication of approximately 96 percent carbon dioxide. To purge the carbon dioxide, a spool piece is removed in the hydrogen supply line and a temporary line from a dry, oil free air supply is connected. Air is introduced at the top of the generator housing to purge the heavier carbon dioxide through the bottom of the generator housing. The hydrogen purity meter is aligned to sample the bottom of the generator. Once purity reaches 100% air, purging may be secured. After successful purging and pressure reduction, the generator housing may be opened and the seal oil supply turned off. For an alternate method of removing carbon dioxide, covers in each end of the generator frame are then opened and forced venting of any carbon dioxide is begun.

9.3.7.4 Safety Evaluation

The hydrogen gas system is a non-nuclear safety system; however, the possibility of a hydrogen gas fire and/or explosion exists.

The hydrogen gas storage area is located such that a malfunction or failure of a component of the hydrogen gas system has no adverse effect on any safety-related system or component. The hydrogen gas systems yard piping is underground with guard piping and appropriately located venting as shown on Figure 10.2.2-5. Gas piping is routed to minimize hazards by locating the gas lines in areas with low fire potential, limited ignition sources and low personnel occupancy. Hazards associated with hydrogen gas accumulation within building areas are minimized by the location of hydrogen equipment and piping in turbine building areas that are well ventilated. Fire protection for those areas containing the hydrogen gas system are provided and described in Section 9.5.1. Valving and pressure control is provided with indication and alarms for conditions that may lead to unsafe system operation.

To ensure that the generator cooling gas does not become contaminated and provide an unsafe condition, the purity of the hydrogen cooling gas in the generator is monitored.

9.3.7.5 Instrumentation and Controls

The hydrogen storage tank has a hi-lo pressure switch that feeds the Main Control Room Annunciator.

a) Generator Hydrogen Pressure - High and Low alarm on the hydrogen control panel;

b) Generator Hydrogen Cooling System Water Detector - High alarm on local hydrogen equipment panel;

c) Pressure Control Station Hydrogen Supply Pressure - Low alarm on local pressure control panel.

A hydrogen cold gas thermostat is located in the generator to provide a temperature sensor that will initiate a signal to cause an alarm if the temperature of the hydrogen gas in the generator becomes excessive.

The purity of the hydrogen gas in the generator is determined through the use of hydrogen purity meter and purity meter blower. The purity meter is a differential pressure instrument which measures the pressure developed by the purity blower. The pressure developed by the blower will vary directly with the density of the generator cooling gas. A temporary gas analyzer can be connected in parallel to the installed hydrogen purity meter. The gas analyzer will provide a more accurate indication of hydrogen purity so that the generator can be operated safely and efficiently.

A temporary purity meter is installed during purging operations to increase personnel safety and to ensure an acceptable purging indication of approximately 96 percent carbon dioxide.

9.3.7.6 Test and Inspection

The hydrogen system is tested functionally under anticipated operating conditions prior to initial plant startup. This verifies that all system units and controls function properly.

9.3.8 ALTERNATE SEAL INJECTION SYSTEM

9.3.8.1 Design Basis

The Alternate Seal Injection (ASI) System consists of equipment designed to provide an alternate source of seal injection cooling water to the Reactor Coolant Pump (RCP) seals when there is a loss of normal seal injection cooling water from the Component Cooling Water (CCW) and the Chemical and Volume Control (CVCS) systems.

9.3.8.2 System Description

The Alternate Seal Injection (ASI) System is designed to provide a back-up source of RCP seal injection cooling to the RCP seals. This system will serve to cool the RCP seal cavity, flush the

cavity, and to minimize deposition of radioactive crud in the seal cavity following the loss of normal RCP seal injection cooling.

The ASI system is designed to provide at least 24 hours of borated cooling water to the RCP seals during a loss of seal water injection to two (2) out of three (3) RCP seals. It shall be capable of providing this borated water to the RCP seals without interruption. The sources of this borated water shall be the ASI Supply Tank, Unit 1 Recycle Monitor Tank (RMT) and the Unit 2 RMT.

The ASI system shall inject borated water to the reactor coolant pump (RCP) seals at a concentration of 4000 + 5 % boric acid. The system is designed to provide a constant flow of approximately 29 gpm regardless of RCS pressure.

The ASI system will initiate when RCP seal water injection flow falls below the minimum allowable level, and actuates the two (2) out of three (3) ASI flow switch logic scheme.

The initiation of the ASI system is delayed to allow for successful restoration of seal injection flow via CSIP and is prevented from starting after 4 minutes. The loss of flow to two (2) out of three (3) flow switches will initiate three (3) timers; the first timer will automatically detonate the two (2) squib valves (1ASI-21 & 1ASI-22) and the second timer will start the ASI pump. The third timer will stop the pump from running if the flow to two (2) out of three (3) flow switches has not been restored within approximately 3.5 minutes. This shall prevent the ASI operation after four (4) minutes if flow is not restored. If seal injection flow via CSIP has been restored prior to expiration of the first timer, all three timers shall reset and no initiation of the pump or squib valves shall occur. The two out of three logic is included for the flow switches to prevent spurious actuations of the ASI System in the event of a single flow switch failure.

The ASI system has a 100 hp ClydeUnion pump skid which supplies borated water from the ASI Supply Tank to the CVCS via ASI system piping. This ASI system piping is connected to CVCS piping at check valve and system boundary 1CS-829. This ASI piping is classified as non-safety, non-seismic and is isolated from the ASME Section III, Class 2 piping of the CVCS by a safety-related check valve 1CS-829. The CVCS pipeline 2CS11/2-837SN-1 is safety-related and therefore ASME Section III, Class 2 piping. This pipeline ties into existing lines 2CS2-311SN-1 & 2CS2-312SN-1, which subsequently flow into RCP seals 1A-SN, 1B-SN & 1C-SN.

In addition to the Class 2 check valve utilized as the system boundary (ASI to CVCS), two squib valves (1AS1-21 & 1AS1-22) shall be utilized to prevent potential pressurization of the ASI pump and CVCS to ASI system cross contamination. The squib valves shall also prevent the flow of seal water from the pump to the RCP seals, in case of a spurious start.

A filter has been added to the ASI discharge piping in order to filter the seal injection water and thereby protect the RCP seals. This filter has a built-in pressure indicator to mechanically represent the differential pressure across the filter. As the filter becomes full and the pressure across the filter increases, a metal indicator raises to represent when the filter needs to be replaced. Additionally, when the internal pressure becomes too high the internal bypass opens to allow flow thus providing fail-safe operation.

The optimum boron concentration of 3800-4200 ppm shall be achieved by utilizing a demineralized water flow indicator and a boric-acid flow indicator (FI-7200). The two fluids shall be mixed as each fluid enters a "Tee", going to the ASI Supply Tank. The demineralized water

shall be connected to the Boron Recycle System (BRS) via a temporary hose connection. When providing borated water to the ASI System, the higher concentrated RMT boron (7000-7750 ppm) shall be mixed with demineralized water to provide the optimum ASI concentration of 3800-4200 ppm. If the Demineralized Water System is not available, boric acid from the Unit 1 RMT & Unit 2 RMT may be provided directly to the ASI Supply Tank. Sampling the RMT's and ASI tank shall be accomplished through provided sample valves.

9.3.8.3 Safety Evaluation

The ASI system does not perform a safety-related function; however it provides additional seal injection cooling capability to the RCP seals, for the purpose of maintaining RCP seal integrity.

9.3.8.4 Tests and Inspections

The ASI System undergoes preoperational and startup tests to verify the continuity and reliability of the system. Instruments are calibrated and automatic controls shall be tested for actuation at the proper set points during this testing. The system components are subjected to nondestructive and hydrostatic testing during construction in accordance with Section VIII, Division 1 of the ASME Code. The system is operated and tested initially with regard to flow paths, flow rate, thermal capacity and mechanical operability. During plant operation, periodic visual inspections and preventive maintenance are conducted on the system components according to normal industrial practice.

9.3.8.5 Instrumentation Application

The system is designed as a completely independent, automatically-actuated back-up seal injection system that is not reliant on the plant electrical or cooling systems.

9.3.8.5.1 Local Controls and Alarms

Local controls and alarms are provided for monitoring of the system and protection of components in the system. An alarm is provided at window 2-3 of ALB-8 on the main control board to indicate ASI System Trouble. An annunciation of the "ASI System Trouble" window will indicate the presence of one or more of the following conditions associated with the ASI System: Automatic Transfer Switch Trouble (includes the following: Improper circuit breaker operation, failsafe condition, aborted engine test due to source 2 unavailability, and aborted plant exerciser test due to source 2 unavailability), Automatic Transfer Switch in "Manual" mode, ASI Pump thermal overload, RMT Pump 1&2B thermal overload, Dedicated Shutdown Diesel Generator 24VDC battery undervoltage, 120VAC feed from PP-1D232 undervoltage, Squib valves in "Bypass" mode, ASI Pump not in "Auto" mode, and low room temperature.

9.3.8.5.2 Instrumentation

Instrumentation is provided to monitor the loss of seal injection flow logic and utilizes a 2-out-of-3 logic for initiation.

9.3.8.5.3 Local Indicators

Local indication is provided for the following:

a) Local indicators are provided to monitor the flow of demineralized water supply to the ASI System and discharge flow of the Recycle Monitor Tank Pump.

b) A local indicator is provided to monitor the level of the ASI Supply Tank.

c) Local indicators are provided to monitor the discharge pressure of the ASI Pump and the pressure of the demineralized water supply to the ASI System.

REFERENCES: SECTION 9.3

9.3.4-1 NS-TMA-2451 letter from T.M. Anderson, W to V. Stello, NRC, May 21, 1981, Westinghouse Volume Control Tank Level

9.4 AIR CONDITIONING, HEATING, COOLING, AND VENTILATION SYSTEM

9.4.0 GENERAL

The objective of the Heating, Ventilation and Air Conditioning Systems is to provide a suitable thermal environment and air quality to ensure personnel comfort, health and safety and proper equipment operation and integrity.

The HVAC Systems provide individual air supplies by means of systems herein described. Normal air flow is directed from areas of low radioactivity to areas of progressively higher radioactivity prior to exhaust. The ventilation arrangement protects personnel and equipment from airborne contaminants and prevents temperature extremes. The ventilation air exhausts from each of the buildings and ventilation systems are located in such a manner as to minimize the possibility of the same air being drawn into a fresh air intake. Exhaust from personnel areas, where potentially radioactive gases may exist, is discharged to the outside atmosphere from roof or wall type ventilators. Exhaust from potentially contaminated areas is discharged to the environment via plant stacks on building roofs as shown on Figure 9.4.0-2. For symbols and abbreviations for HVAC systems see Figure 9.4.0-1.

Redundant air conditioning and ventilating equipment is provided in selected areas to assure HVAC Systems operation for safety of personnel and maintenance of proper operating environment for vital equipment.

The HVAC systems, as designed, provide localized ventilation units to maintain a controlled environment in certain selected areas. Tornado missile protection is provided for all safety related outside air intake and discharge structures to protect essential portions of the HVAC system from the effects of hurricanes, tornadoes, and externally generated missiles.

Table 9.4.0-1 indicates the indoor and outdoor temperatures and humidities anticipated in the plant during normal plant operation.

Plant HVAC Systems General System Design and Operation

The Plant Ventilation Systems are presented as follows:

a) Control Room Habitability System is discussed in Section 6.4 and shown on Figure 9.4.1-1.

b) Containment Cooling System is discussed in Section 6.2.2 and shown on Figure 6.2.2-3.

c) Containment Building Ventilation System is discussed in Section 9.4.7 and shown on Figure 6.2.2-3.

d) Engineered Safety Features (ESF) Filter Systems are discussed in Section 6.5.1 and shown on Figures 9.4.1-1, 9.4.2-1, and 9.4.3-2.

e) Control Room Area Ventilation System is discussed in Section 9.4.1 and shown on Figure 9.4.1-1.

f) Spent Fuel Pool Area Ventilation System is discussed in Section 9.4.2 and shown on Figures 9.4.2-1 and 9.4.2-2.

g) Reactor Auxiliary Building Ventilation System is discussed in Section 9.4.3 and shown on Figures 9.4.3-1 and 9.4.3-2.

h) Waste Processing Building HVAC System is discussed in Section 9.4.3 and shown on Figures 9.4.3-3 through 9.4.3-8.

i) Turbine Building Area Ventilation System is discussed in Section 9.4.4 and shown on Figure 9.4.4-1.

j) Reactor Auxiliary Building ESF Equipment Cooling System is discussed in Section 9.4.5 and shown on Figures 9.4.3-1, 9.4.3-2 and 9.4.5-1.

k) Reactor Auxiliary Building Switchgear Ventilation System is discussed in Section 9.4.5 and shown on Figure 9.4.5-1.

l) Reactor Auxiliary Building Electrical Equipment Protection Rooms Ventilation System is discussed in Section 9.4.5 and shown on Figure 9.4.5-1.

m) Diesel Generator Building Ventilation System is discussed in Section 9.4.5 and shown on Figure 9.4.5-2.

n) Fuel Oil Transfer Pumps Room Ventilation System is discussed in Section 9.4.5 and shown on Figure 9.4.5-2.

o) Emergency Service Water Intake Structure Ventilation System is discussed in Section 9.4.5 and shown on Figure 9.4.5-2.

p) Primary Shield and Reactor Supports Cooling System is discussed in Section 6.2.2 and shown on Figure 6.2.2-3.

q) (Deleted by Amendment 48).

r) Essential Services Chilled Water System is discussed in Section 9.2.8 and shown on Figures 9.2.8-1, 9.2.8-2 and 9.2.8-3.

s) Non-Essential Services Chilled Water System is discussed in Section 9.2.9 and shown on Figures 9.2.9-1 and 9.2.9-2.

t) Containment Vacuum Relief System is discussed in Section 6.2.1.1.3.4 and shown on Figures 6.2.2-3 and 6.2.1-306.

u) Control Rod Drive Mechanism (CRDM) Ventilation System is discussed in Section 9.4.8 and shown on Figure 6.2.2-3.

v) Computer and Communication Room Ventilation System is discussed in Section 9.4.9 and shown on Figures 9.4.9-1 and 9.4.9-2.

w) Battery and HVAC Equipment Room Ventilation System is discussed in Section 9.4.9 and shown on Figures 9.4.9-1 and 9.4.9-2.

x) Turbine Building Decontamination Facility HVAC System is discussed in Section 9.4.10 and shown on Figures 9.4.10-1 and 9.4.10-2.

System flow rates are based on summer cooling requirements and assuming various equipment is in operation. Consideration was given to the use, load and diversity factors inherent in such operation. In winter, the air is heated by the supply units' electric heating coils or electric heating units sized using minimum design space temperature stated in Table 9.4.0-1.

For convenience, all spaces included in the above mentioned systems, are divided into three categories: Clean, Low Radiation Potential and High Radiation Potential. Clean areas include such spaces as the Control Room, electrical equipment room and other general areas of extended occupancy. Low potential radiation areas will include such spaces as hot locker room, boric acid storage cell, sump tank cell and pump cells. High potential radiation areas include such spaces as waste hold up, spent resin storage tank cell and chases for radioactive services.

More air is supplied to clean areas than exhausted from clean areas to assure outward air migration; conversely, less air is supplied than exhausted from potentially higher contamination areas to assure inward migration from adjoining cleaner or low radiation potential areas.

To control airborne contaminants during maintenance, provisions are made to assure continuous and uninterrupted airflow.

1. Large capacity systems have multiple filtration trains connected to common exhaust ductwork systems.

2. Instrumentation is provided for volume control of both air supply and air exhaust. This facilitates the reduction of air flows in case one of the units is shut down for maintenance.

3. Systems are designed with sufficient redundancy.

4. Ductwork systems require no removable pieces for access to and maintenance of equipment.

Easy access is provided during service, maintenance, decontamination, and filter changes.

1. All filtration trains are limited to approximately 30,000 cfm capacity.

2. Charcoal loading and unloading is accomplished by means of a compact pneumatic conveying system.

3. Elevators are provided for moving new and used filters to and from the installation sites having multiple filtration trains for large capacity systems.

4. For ease of maintenance, all redundant fans connected to a common ductwork or plenum are provided with isolation dampers on both downstream and upstream sides.

5. All decontamination areas are adjacent to access corridors and are provided with sufficient ventilation.

Protection of safety related systems, structures and components, from the effects of natural and accidental phenomena are discussed in the following sections:

Tornado Wind	2.3 and 3.3.2
Hurricane Wind	2.3 and 3.3.1
Flooding	2.4.3 and 3.4.1
Missile Protection	3.5
Pipe Whip	3.6.1 and 3.6.2
Jet Impingement	3.6.1 and 3.6.2

Vent Stub Stacks

Ventilation exhaust from potentially contaminated areas will be discharged to the environment through four major release points located above the roofs of various buildings. The four release points are in a form of stub stacks varying approximately 10 to 20 ft. above the building roofs. One stack is located in the Reactor Auxiliary Building, two stacks are located in the Waste Processing Building and one stack is located in the Turbine Building.

These four major plant release points are shown on Figure 9.4.0-2.

Table 9.4.0-2 is arranged to show corresponding flow rates, identification of systems and release point elevations.

9.4.1 CONTROL ROOM AREA VENTILATION SYSTEM

The Control Room Area Ventilation System consists of an Air Conditioning System and an emergency filtration system to serve the Control Room.

Additional details of the Control Room Area Ventilation and habitability systems are given in Section 6.4.

9.4.1.1 Design Bases

The Control Room Air Conditioning System (CRACS) provides heating, ventilation, cooling, filtration, air intake and exhaust isolation, and 50 percent relative humidity for the control room envelope (as described in Section 9.4.1.2) during normal operation and a design basis accident.

Systems are designed to include the effects of the most adverse single active component failure.

The high energy piping systems outside containment are listed and described in Section 3.6A.2. Those listed systems are the CVCs, SGBS, FWS and the AFS. A discussion of the analysis is provided for those systems in Section 3.6A.2 that demonstrate that the Control Room will not be adversely affected by a pipe crack or break in an adjacent area. Figure 3.6A-2 shows the only high energy piping adjacent to the Control Room with indication of break locations and jet impingement envelopes.

The steam lines near the Control Room (elevation 305 feet) are located in the turbine building at elevation 286.00 feet and separated by the Category I wall of the RAB. The Control Room, including outside air intakes for control room ventilation will not be adversely affected by any high energy pipe breaks. The main steam line may be slightly radioactive but as discussed in Sections 15.1.5, 6.4.4 and 9.4.1 radiological impact would be limited to below acceptable levels by ventilation systems and wall shielding.

The Control Room Air Conditioning is designed:

a) To maintain the Control Room at a design temperature of 75 F dry bulb and maximum relative humidity not to exceed 50 percent, assuring personal comfort as well as suitable environment for continuous operation of controls and instrumentation.

b) To detect the introduction of radioactive material into the Control Room and automatically isolate all air intakes and exhausts upon a high radiation signal or SIS signal and to remove airborne radioactivity from the Control Room to the extent that dose to the Control Room operator following a design basis accident does not exceed the limit specified in the General Design Criteria 19. In addition, the RAB Normal Ventilation System will be secured, and the RAB Emergency Exhaust System (RABEES) will be started. The RAB Normal Ventilation System must be secured to preclude the possibility of postulated system failures from impacting the ability of the Control Room Envelope (CRE) to maintain a positive pressure of > 1/8 INWG relative to adjacent areas. When the RAB Normal Ventilation System is secured, the RAB Emergency Exhaust System is initiated to maintain the potentially contaminated areas of the RAB at sub-atmospheric pressure in an effort to limit outleakage and to remove radon gas from the RAB.

c) To detect the introduction of smoke into the Control Room and automatically initiate a Control Room Isolation, and to operate in conjunction with the Fire Detection System to remove smoke from the Control Room in the event of fire.

d) To be powered by the redundant Channel A and Channel B ESF buses.

e) To meet single component active failure in the system or a failure in a single emergency power supply coincident with loss of offsite power.

f) To meet Safety Class 3 and Seismic Category I requirements and to be tornado and missile protected. The system is physically separated from all other systems by walls and doors.

g) To permit testing, adjustment, and inspection of the principal system components on a regular basis to assure system functional reliability.

9.4.1.2 System Description

The control room envelope, which is referred to as the "Control Room," includes, in addition to the Control Room, the following auxiliary spaces.

a) Office area

b) Relay and termination cabinet rooms

c) Kitchen and sanitary facilities

d) Component cooling water surge tank room

The computer rooms, protection and control equipment rooms, communication rooms, instrument repair room, and cable spreading rooms located in the Reactor Auxiliary Building are ventilated and cooled by independent cooling systems.

The Control Room Air Conditioning System is shown on Figure 9.4.1-1 and principal system components design data are listed and described in Table 9.4.1-1.

The CRACS is designed to maintain the control room envelope at a design temperature of 75°F under normal and Design Bases Accident conditions. Space relative humidity is controlled not to rise above 50 percent. The air is cooled by a cooling coil. The chilled water supply to the cooling coil is provided by the Essential Services Chilled Water System (see Section 9.2.8). When heating is required, the air is heated by the electric heating coils to maintain the design space temperature stated above.

The Control Room Air Conditioning System consists of the following:

a) The supply system consists of two 100 percent capacity air handling units (one operating and one stand-by). The air handling units are arranged in parallel. Each air handling unit includes, in the direction of air flow, a motorized isolation damper, medium efficiency filter, chilled water cooling coil, centrifugal fan, electric reheat coil, and motorized butterfly valve.

   An outside air intake is provided for the supply system. The air intake is provided with two motorized isolation valves arranged in series and is protected from the tornado negative pressure effects by a self-acting tornado damper. The intake is stormproofed and missile protected.

b) The exhaust system consists of two 100 percent capacity (one operating and one stand-by) fans. Each fan is provided with an inlet and an outlet motorized damper to prevent air recirculating through the idle fan.

   The exhaust system is provided with two motorized isolation valves arranged in series and protected from tornado negative effects by means of a self-acting tornado damper. The exhaust system is stormproofed and missile protected.

c) The smoke purge system consists of two 100 percent capacity (one operating and one stand-by) purge fans. Each purge fan is provided with a gravity discharge damper to prevent air recirculation. The purge system inlet is provided with redundant motorized isolation valves arranged in series.

d) The Emergency Filtration System consists of two 100 percent capacity filtration trains arranged in parallel. Each filtration train contains in the direction of airflow, the following components:

   (1) One motorized valve

   (2) One centrifugal fan

   (3) One motorized valve

   (4) One flow element

   (5) A Demister

   (6) One electric heating coil

   (7) HEPA pre-filter bank

   (8) Charcoal adsorber bank

   (9) HEPA after-filter bank

   (10) One motorized isolation valve

   (11) Connecting duct to other unit discharge

For post-accident operation, each Emergency Filtration System can be independently fed from either of the emergency outside air intakes (intake points 10 or 11A) as shown on Figure 9.4.0-2.

9.4.1.2.1 Normal Operation

During normal operation, the Control Room Air Conditioning System operates in a recirculation mode with the Emergency Filtration System de-energized. The outside makeup air mixes with the returned air before it is conditioned by the air handling units. The Control Room is maintained at a slightly positive pressure with respect to the adjacent area so that the air from

other sources entering the Control Room is minimized. The pressurization of the Control Room is maintained automatically by means of modulating exhaust fan dampers.

Each of the two supply air handling units are served by common supply and return ductwork with all necessary accessories to make the system complete and operable. All chilled water to the cooling coils is provided by Essential Services Chilled Water System (see Section 9.2.8).

9.4.1.2.2 Post-accident Operation

Upon receipt of a Safety Injection Actuation Signal (SIAS), a high radiation signal from a radiation monitor located within each air intake (one Normal OAI and two Emergency OAIs) or a smoke signal at the Normal OAI, a Control Room Isolation signal is generated and the following functions are performed automatically:

a) All isolation valves at the normal outside air intake will close.

b) All isolation valves in the Control Room Smoke Purge System will close (these valves are normally closed).

c) Both emergency filtration units will start and their respective valves will open for full-recirculation mode.

d) All isolation valves in the Normal Exhaust System will close and the operating exhaust fan will be de-energized.

e) Dampers for lavatory and kitchen which normally by-pass the return system will open.

f) The RAB Normal Ventilation System will be secured, and the RAB Emergency Exhaust System (RABEES) will be started. The RAB Normal Ventilation System must be secured to preclude the possibility of postulated system failures from impacting the ability of the Control Room Envelope (CRE) to maintain a positive pressure of > 1/8 INWG relative to adjacent areas. When the RAB Normal Ventilation System is secured, the RAB Emergency Exhaust System is initiated to maintain the potentially contaminated areas of the RAB at sub-atmospheric pressure in an effort to limit outleakage and to remove radon gas from the RAB.

Following the completion of the above automatic functions, the operator will perform the following tasks:

a) Place one of the two emergency filtration trains on standby.

b) Select and open one emergency outside air intake path during radiological accident to pressurize the Control Room (these paths are normally closed).

During the radiological accident, the Emergency Filtration System will process a mixture of Control Room air and a small quantity of outside air through charcoal filters and maintain the control room envelope under positive pressure of + 1/8 in. wg. Air is continuously drawn from the supply air subsystem blended with outside air, processed through the charcoal filtration system and supplied to the Control Room. A balance valve is provided at the point of initial takeoff from the supply air subsystem.

9.4.1.2.3 Smoke Purge Operation

In the event of a fire in any area of the control room envelope, redundant smoke detectors will shutdown the system and actuate an alarm for operator action. The operator will remote manually execute the smoke purging operation by changing the operational status of valves, dampers, and fans and the corresponding air flow rates according to those indicated in Table 9.4.1-2 when smoke is generated in the control room.

Thus, the airflow pattern of normal exhaust system supplemented by the purge system becomes a once-through type. An outside air purge makeup intake is located at the South Wall of the Reactor Auxiliary Building Elevation 317 ft. (intake point 6); purge vents are connected to the local stub stack at Elevation 346 ft. (release point 1). Purge fans are located outside the control room envelope boundary.

When the smoke is detected in the outside air intake, the system will automatically switch to the isolation mode.

Valve and damper position-indication lights will allow continuous monitoring of the system performance and will confirm all remote manual control actions taken.

9.4.1.3 Safety Evaluation

Continued operation of the Control Room Air Conditioning System (CRACS) during both normal and emergency conditions to maintain the Control Room temperature and humidity will be assured by the following:

a) System components are designed to meet Safety Class 3 and Seismic Category I requirements with the exception of the normal and smoke exhaust fan systems.

b) System components are separated and redundant so that a single failure of an active component in a system or the single failure of an emergency power supply coincident with loss of offsite power cannot result in loss of the system functional performance capability. A system single failure analysis is presented in Table 9.4.1-4.

c) During loss of offsite power, all active components, such as valve and damper operators, fan motors, control and instrumentation will be served by their respective redundant emergency power sources.

d) The CRACS is designed to ensure that any postulated single failure will not adversely affect the capability of the system to satisfy its design objectives. A single failure of an electric heating coil unit or cooling unit will not prevent the control room HVAC system from completing its safety function (refer to Table 9.4.1-4). Butterfly valves and/or dampers are provided to isolate flow through affected heating/cooling units as necessary. Redundant units are provided to assure adequate cooling or heating as required. Malfunctioning HVAC equipment can be readily identified and isolated from the Control Room. There is no significant effect to the control room environment from the isolated malfunctioning train. Heating and cooling equipment for the Control Room are remotely located and are not in the Control Room.

In any event, the design of the plant is such that the Control Room can be evacuated and the plant can be maintained in a safe condition from the auxiliary control panel (refer to FSAR Section 7.4.1.11). The auxiliary control panel area is serviced by totally independent HVAC units.

e) The ventilation system has sufficient redundancy to preclude inadequate heating or cooling as described in Section 7.3.1.5.7 and as shown on Figure 7.3.1-17 and Table 9.4.1-4.

The adequacy of the CRACS to limit the radiation doses to control room personnel is demonstrated in Chapter 15, Section 15.6.5.4.4.

Detection of radioactivity in the control room environment is provided by radiation monitors as described in Section 11.5 and 12.3.4. This system permits immediate and automatic isolation of the control room normal and emergency outside air intake and exhaust ducts upon receipt of a high radiation signal and enables the operator to select the least contaminated emergency outside air intake for control room pressurization. Adjustable high radiation alarms are provided to alert the operator of changes in contamination levels at both post-accident air intakes. The control room area ventilation system isolates all paths to the environment upon receipt of a high radiation signal as described in FSAR Section 6.4.3.

Smoke detectors in the Control Room will actuate an alarm so that the operator can initiate the smoke purge operation in the event of a fire.

See Section 9.5.1 for the protection of the CRACS from the effects of fire.

9.4.1.4 Inspection and Testing Requirements

The CRACS undergoes preoperational and startup tests as described in Section 14.2.12.1.58. Periodic tests are required as described in the Technical Specifications. Inservice inspection requirements are described in Section 6.6. Valve testing requirements are described in Section 3.9.6.

9.4.2 SPENT FUEL POOL AREA VENTILATION SYSTEM

The Spent Fuel Pool Area Ventilation System is a part of the Fuel Handling Building (FHB) Heating, Ventilating, and Air Conditioning (HVAC) System. The Fuel Handling Building HVAC system consists of the following systems:

a) Air Conditioning System for the operating floor (or spent fuel pool area) of Fuel Handling Building.

b) Emergency Exhaust System for the operating floor of Fuel Handling Building which is discussed in Section 6.5.1.

c) Normal Ventilation System for areas below operating floor of Fuel Handling Building.

d) Spent Fuel Pool Pump Room Ventilation System.

9.4.2.1 Design Bases

9.4.2.1.1 Air Conditioning System for the Operating Floor of Fuel Handling Building

The Air Conditioning System for the operating floor of Fuel Handling Building is designed:

a) To provide ventilation for spent fuel pool areas.

b) To direct air from areas of low potential radioactivity to areas of higher potential radioactivity.

c) To provide an ambient temperature below 89 F (summer) and above 60 F (winter) for areas between the operating floor and 19 ft. above operating floor. For areas above 19 ft. above the operating floor, ambient temperature will be maintained below 104 F.

d) To detect and monitor radiation levels in the pools area (refer to Sections 11.5 and 12.3.4 for details).

e) To have seismic support for exhaust ducts above the fuel pool areas, and for ductwork penetrating from RAB to the operating floor of FHB as shown on Figure 9.4.2-1 and radiation monitors located along the walls of the pool areas.

f) To provide personnel comfort, personnel safety protection and equipment and controls functional protection.

g) To reduce operator dose due to evaporation of contaminated water in the spent fuel pools area of the operating floor.

h) To provide means of isolating the operating floor upon occurrence of a fuel handling accident or upon any accidental release of radioactive material.

i) To provide redundant isolation dampers and radiation monitor to meet single failure criterion.

9.4.2.1.2 Emergency Exhaust System for the Operating Floor of Fuel Handling Building

Refer to Section 6.5.1 for detailed discussion of Emergency Exhaust System for the operating floor of Fuel Handling Building.

9.4.2.1.3 Normal Ventilation System for Areas below Operating Floor

The Normal Ventilation System for areas below operating floor is designed:

a) To provide ventilation for areas below operating floor, and cooling for mechanical and electrical equipment for protection of equipment motors.

b) To direct air flow from areas of low potential radioactivity to areas of progressively higher potential radioactivity.

9.4.2.1.4 Spent Fuel Pool Pump Room Ventilation System

The Spent Fuel Pump Room Ventilation System is designed:

a) To provide cooling for mechanical equipment (spent fuel pool pumps and heat exchanger, etc.) protection of equipment motors.

b) To provide cooling for the Emergency Exhaust System for protection of the fan motors during a fuel handling accident.

c) To provide sufficient redundancy in the ventilation system to meet the single active failure criterion.

d) To provide sufficient physical separation or barrier for components, piping and ductwork to protect essential portions of the system from missiles and pipe whip.

e) To meet Safety Class 3 and Seismic Category I requirements.

f) To preclude failures of non-Seismic Category I equipment or components from affecting the Spent Fuel Pool Room Ventilation System.

g) To detect and isolate portions of the system in the event of failures or malfunctions.

9.4.2.2 System Description

9.4.2.2.1 Air Conditioning System for the Operating Floor of Fuel Handling Building

The Air Conditioning System for the Operating Floor of Fuel Handling Building is shown on Figure 9.4.2-1 and design data for system components are presented in Table 9.4.2-1.

The Air Conditioning System consists of a supply system and an exhaust system.

The supply system consists of four supply air handling units. Each unit includes, in the direction of air flow an outside air intake louver with bird screen, an isolation damper, medium efficiency filters, electric heating coil, chilled water cooling coil, electric reheat coil and a centrifugal fan. Outside air is drawn through the unit and supplies to the operating floor through a sheet metal duct distribution system. Normally, all fans are operating. Two Safety Class 3 and seismically supported isolation dampers arranged in series are located in the common duct penetrating to the operating floor. The chilled water flow diagram and piping for the supply air handling units is described in Section 9.2.9.

Cooled air is continuously supplied along two sides of the fuel pools by linear diffusers. Air movement over the pool will not cause visible disturbance of the fuel pool water. Air is continuously exhausted at the ceiling by the exhaust system.

The exhaust system consists of four exhaust units. Each unit includes an isolation damper, a centrifugal fan and a discharge isolation damper. More air is exhausted at the fuel pool areas by drawing air from outside the fuel pool areas. During the cask decontamination process, air is transferred to the decontamination enclosure and exhausted by a separate exhaust fan which is connected to the normal exhaust system. Dampers are provided to isolate the decontamination

enclosure during periods when decontamination is not in progress. The air distribution system for the spent fuel pools and fuel transfer canals is shown on Figure 9.4.2-2.

Upon receipt of high radiation signal, the radiation monitors located along the walls of each fuel pool (a total of 24 area monitors is provided) will cause isolation dampers in the common ducts to close before the contaminated air rising from the surface of the pools reaches the ducts; the Air Conditioning System will be de-energized. Consequently, the Emergency Exhaust System will be energized and the operating floor will be maintained under a negative pressure of 1/8 in./wg. Refer to Section 6.5.1 for a discussion of Emergency Exhaust System for the operating floor of the Fuel Handling Building.

Upon detection of smoke in the ventilation system, the supply fans will automatically be tripped to prevent the spread of smoke and reduce the supply of air to the fire in accordance with NFPA 90A.

The system components are protected against high and moderate energy piping breaks (see Section 3.6).

9.4.2.2.2 Emergency Exhaust System for Operating Floor of FHB

Refer to Section 6.5.1 for a discussion of Emergency Exhaust System for the operating floor of Fuel Handling Building.

9.4.2.2.3 Normal Ventilation System for Areas Below Operating Floor of FHB

The Normal Ventilation System for space below the operating floor of FHB is shown on Figure 9.4.2-1 and design data for system components presented in Table 9.4.2-1. The Ventilation System consists of a Normal Supply System and a Normal Exhaust System.

The Normal Supply System consists of normal supply system-north and normal system-south. The normal supply system-north serves the northern half of the areas below the operating floor and the normal supply system-south serves the southern half of the areas below the operating floor. Each sub-system consists of two parallel 100 percent capacity vane-axial fans (one operating, one standby). Each fan is provided with pneumatic inlet and discharge dampers to prevent air recirculation through the idle fan.

The fan inlets are connected to a common plenum and air is drawn from outside and supplied to various spaces below the operating floor through an air intake louver, damper, medium efficiency filters and an electrical heating coil.

A missile shield is provided for air intake of normal supply system-south, so that the safety related equipment located underneath the air intake is protected.

Air is continuously exhausted from the areas below the operating floor by the Normal Exhaust System. Each exhaust sub-system consists of two parallel 100 percent capacity centrifugal fans (one operating, one standby). Each fan is provided with pneumatic inlet and discharge dampers to prevent air recirculation through the idle fan.

An electric unit heater and an exhaust fan provide air conditioning in the north heating and ventilating equipment room.

Upon detection of smoke in the ventilation system, the supply fans will automatically be tripped to prevent the spread of smoke and reduce the supply of air to the fire in accordance with NFPA 90A.

9.4.2.2.4 Spent Fuel Pool Pump Room Ventilation System

The Spent Fuel Pool Pump Room Ventilation System is shown on Figure 9.4.2-1 and design data for system components are presented in Table 9.4.2-1.

The system consists of two 100 percent capacity air handling units (one operating, and one standby). Each air handling unit includes medium efficiency filters, a chilled water cooling coil and a centrifugal fan. The chilled water to the cooling coil of the air handling unit is provided from

Essential Service Chilled Water Systems (see Section 9.2.8). This is compatible with the emergency power supplies to these units as described in Section 8.3.

The air handling unit supplies cooled air to spent fuel pool pumps and heat exchangers area, MCC room, H&V equipment area, and emergency filtration area during normal and emergency conditions. Ductwork and piping to each air handling unit are physically separated from each other to assure that single failure criterion is met.

9.4.2.3 Safety Evaluation

9.4.2.3.1 Air Conditioning System for the Operating Floor of FHB

The Air Conditioning System for the operating floor of FHB is not safety related and it is not required to operate during accident conditions. Upon the occurrence of a design basis accident, failure of this non-safety portion will not have any detrimental effect on the emergency exhaust system of FHB. The Emergency Exhaust System is designed to Safety Class 3 and Seismic Category I requirements. Refer to Section 6.5.1 for a discussion of the Emergency Exhaust System of FHB. The isolation dampers located in the common supply and exhaust ductwork penetrating from RAB to FHB are designed to satisfy Safety Class 3 and Seismic Category I requirements.

The exhaust ducts above the pools are seismically supported to prevent them from falling into the pools during a seismic event. Failure of any non-safety portion of the system will not affect any safety related equipment.

The radiation monitors located around the walls of each of the fuel pools are safety related and seismically supported.

Upon the occurrence of a fuel handling accident, the radiation monitors, described in Sections 11.5 and 12.3.4, will produce a hi radiation signal, the fail closed isolation dampers located in common supply and exhaust ducts will be closed, and the operating floor of FHB will be isolated.

The Emergency Exhaust System provides the ability to mitigate the consequences of a fuel handling accident in order to limit the potential offsite exposures to within the acceptable limits of 10 CFR 50.67. The Emergency Exhaust System maintains a negative pressure in the

operating floor of FHB. This has an effect of inducing inward leakage and prohibiting any outleakage of unfiltered air. The exhaust air is drawn through the filtration system before it is released to the outside environment.

Upon a loss of power, the Air Conditioning System for the operating floor will be shut down.

9.4.2.3.2 Emergency Exhaust System for the Operating Floor of FHB

Refer to Section 6.5.1 for a discussion of Emergency Exhaust System of FHB.

9.4.2.3.3 Normal Ventilation System for Areas Below Operating Floor of FHB

The Normal Ventilation System for areas below the operating floor of FHB is not safety related except for the isolation dampers located in the supply and return ducts of the loading areas. The isolation dampers are designed to meet Safety Class 3 and Seismic Category I requirements. Upon the occurrence of a hi radiation signal, the isolation dampers will be closed and the operating floor and the loading area will be isolated from other areas of FHB.

Each space of the area below the operating floor was analyzed during the system design to assure that air flow is directed from areas of low potential radioactivity to areas of progressively higher potential radioactivity.

Following a fuel handling accident, the Normal Ventilation System for areas below the operating floor will continue to function. Upon a loss of power the Normal Ventilation System will shut down.

Failure of any non-safety portion of the system will not affect any safety related equipment.

9.4.2.3.4 Spent Fuel Pool Pump Room Ventilation System

The Spent Fuel Pool Room Ventilation System is designed to meet Safety Class 3, and Seismic Category I requirements. Each air handling unit including ductwork is physically separated from the other unit, to assure the unit is capable of meeting the single failure criteria. A single failure analysis of the Spent Fuel Pool Pump Room Ventilation System is presented in Table 9.4.2-2. Failure in one of the components of the Spent Fuel Pool Pump Room Ventilation System does not affect the operability of the system.

In the event of loss of offsite power, the air handling units of the Spent Fuel Pool Pump Room Ventilation System will be powered by redundant diesel generators (see Section 8.3).

9.4.2.4 Inspection and Testing Requirements

To ensure and demonstrate the capability of the Spent Fuel Pool Area Ventilation System, the system components and equipment are subjected to testing to verify proper wiring and control hookup, proper function of system components and control devices, and to establish system design airflow rates.

The ventilation systems undergo preoperational and startup tests as described in Section 14.2.12. Periodic tests as required by the Technical Specifications will be performed. Inservice inspection will be performed in accordance with Section 6.6 for Safety Class 3 components.

9.4.3 AUXILIARY AND RADWASTE AREA VENTILATION SYSTEMS

The Reactor Auxiliary Building (RAB) Ventilation System and Waste Processing Building (WPB) HVAC System are two separate and independent systems.

The Reactor Auxiliary Building (RAB) Ventilation System consists of the following systems:

1. RAB Normal Ventilation System, which provides normal ventilation for the Reactor Auxiliary Building during normal plant operation. Refer to Sections 9.4.3.1.1, 9.4.3.2.1 and 9.4.3.3.1 for a detailed discussion.

2. RAB Emergency Exhaust System, which maintains selected potentially contaminated areas (See Section 6.5.1.1.2) of RAB below atmospheric pressure following a Safety Injection Actuation Signal (SIAS) or a Control Room Isolation Signal (CRIS) and minimizes unfiltered outleakage of airborne radioactive materials. Refer to Section 6.5.1 for a detailed discussion.

3. RAB NNS-Ventilation Systems, which are discussed in Sections 9.4.3.1.2, 9.4.3.2.2 and 9.4.3.3.2.

4. RAB ESF Equipment Cooling System which provides emergency cooling by means of fan-coolers, for areas containing equipment essential for safe shutdown. Refer to Section 9.4.5 for a detailed discussion.

5. RAB switchgear rooms, and the RAB electrical equipment protection rooms are ventilated by two separate systems which are discussed in Section 9.4.5.

The portions of the RAB Normal Ventilation System, which serve areas included in the RAB Emergency Exhaust System, will be isolated automatically following a Safety Injection Actuation Signal (SIAS) or a Control Room Isolation Signal (CRIS). At that time, the RAB Emergency Exhaust System will be actuated and will keep the areas connected to the emergency exhaust systems under a slightly negative pressure. All exhaust will be passed through a filtration system for treatment before release.

The local ESF fan coolers will start simultaneously with the RAB Emergency Exhaust System and are completely separated and independent from any other RAB ventilation system. The fan coolers will circulate air in rooms containing equipment essential for safe shutdown.

The Waste Processing Building (WPB) HVAC System consists of the following systems:

1. Waste Processing Areas Ventilation System, which provides ventilation for the Waste Processing Building areas during normal plant operation. See Section 9.4.3.2.3 for a detailed discussion.

2. WPB Control Room HVAC System, which provides heating, ventilation and air conditioning. See Section 9.4.3.2.4 for a detailed discussion.

3. Personnel Handling Facility HVAC System, which provides heating, ventilating and air conditioning for such areas as the locker room, health physics work area, operating

area, and monitor area in the Waste Processing Building. See Section 9.4.3.2.5 for a detailed discussion.

4. Office and Laundry Areas HVAC System, which provides heating, ventilating and air conditioning for the office areas and the laundry areas. See Section 9.4.3.2.6 for a detailed discussion.

5. Laboratory Areas HVAC System, which provides heating ventilating and air conditioning for areas in the laboratory areas and ventilation for the fume hoods. See Section 9.4.3.2.7 for a detailed discussion.

6. Instrumentation and Control Shop HVAC System which is discussed in Section 9.4.3.2.8.

9.4.3.1 Design Bases

9.4.3.1.1 RAB normal ventilation system

1. The RAB Normal Ventilation System (RABNVS) is designed to provide normal ventilation for areas containing equipment essential for safe shutdown including CVCS chiller area, 480 V auxiliary bus area, areas containing non-essential equipment, surrounding access aisles and RAB stairways and H&V equipment rooms. Refer to Figures 9.4.3-1 and 9.4.3-2 for all areas ventilated. The RABNVS is also designed to maintain space temperatures as indicated in Table 9.4.0-1 during normal plant operation.

2. Ventilation system discharges are monitored to detect and control the release of airborne radioactivity. Refer to Sections 11.5 and 12.3.4 for details.

3. The normal supply and exhaust systems are designed with sufficient redundancy to ensure continuous reliable performance during normal plant operations. The supply systems are provided with two 100 percent capacity redundant operating fans (one operating and one standby), the exhaust systems are provided with four 25 percent capacity operating fans. Also, as described in Section 9.4.7, the containment pre-entry purge exhaust unit serves as a standby unit for RAB Normal Exhaust System.

4. Maintain air flow from areas of low potential radioactivity to areas of progressively higher potential radioactivity.

5. Isolate service to selected post-accident, potentially contaminated areas (see Section 6.5.1.1.2) upon receipt of a Safety Injection Actuation Signal (SIAS) or a Control Room Isolation Signal (CRIS), to enable the RAB Emergency Exhaust System to maintain these areas below atmospheric pressure.

6. The system isolation valves which are required to function following a design basis accident, will be powered by redundant electric safety buses A and B.

9.4.3.1.2 RAB NNS-Ventilation System

The RAB NNS-Ventilation System is designed to:

a) Provide normal ventilation to maintain a controlled environment suitable for plant personnel and continuous operation of systems and equipment in areas not served by the RABNVS which is discussed in Section 9.4.3.1.1.

For indoor space design temperatures see Table 9.4.0-1.

b) Maintain airflow from areas of low potential radioactivity to areas of progressively higher potential radioactivity.

9.4.3.1.3 Waste Processing Areas Ventilation System

The Waste Processing Areas Ventilation System is designed:

a) To provide normal ventilation to maintain a controlled environment suitable for plant personnel and continuous operation of systems and equipment.

b) To direct airflow from areas of low potential radioactivity to areas of progressively higher potential radioactivity.

c) To provide local cooling during normal plant operation in such areas as corridors, HVAC chillers room and switchgear room.

d) To monitor the ventilation system discharge to detect and control release of airborne radioactivity (see Sections 11.5 and 12.3.4).

e) To provide sufficient redundancy in the normal supply and exhaust systems to ensure continuous reliable performance during normal operations.

9.4.3.1.4 WPB Control Room HVAC System

The WPB Control Room HVAC is designed to:

a) Provide personnel comfort, personnel safety protection, and equipment and controls functional protection.

b) Direct airflow from areas of low potential radioactivity to areas of progressively higher potential radioactivity.

9.4.3.1.5 WPB Personnel Handling Facility HVAC System

The WPB Personnel Handling Facility HVAC System is designed to;

a) Provide personnel comfort, personnel safety protection, and equipment and controls functional protection.

Direct airflow from areas of low potential radioactivity to areas of progressively higher potential radioactivity.

9.4.3.1.6 WPB office and laundry areas HVAC system

The WPB office and Laundry Areas HVAC System is designed to:

1. Provide personnel comfort, personnel safety protection, and equipment functional protection.
2. Direct airflow from areas of low potential radioactivity to areas of progressively higher potential radioactivity.
3. Provide direct supply and exhaust for the dryers in the laundry areas.

9.4.3.1.7 WPB laboratory areas HVAC system

The WPB Laboratory Areas HVAC System is designed to:

1. Provide personnel comfort, personnel safety protection, and equipment functional protection.
2. Direct airflow from low contaminated areas to areas of progressively higher contamination.
3. Provide direct air supply and exhaust system for the fume hoods in the laboratory areas.

9.4.3.1.8 WPB instrumentation and control shop HVAC system

The WPB Instrumentation and Control (I&C) Shop HVAC System is designed to provide personnel comfort, personnel safety protection, and equipment functional protection.

9.4.3.2 System Description

9.4.3.2.1 RAB normal ventilation system

The RAB Normal Ventilation System (RABNVS) is shown on Figures 9.4.3-1 and 9.4.3-2. Design data for principal system components are presented in Table 9.4.3-1. The once through type system consists of a supply system, a normal exhaust and a filtered emergency exhaust system. Under accident conditions, spaces containing major containment penetrations and selected potentially contaminated areas (See Section 6.5.1.1.2) are automatically isolated, the normal ventilation system shuts down, and the air from those areas is treated by the filtered RAB Emergency Exhaust System prior to release to the environment.

The filtered RAB Emergency Exhaust System, is an Engineered Safety Feature (ESF) which contains high efficiency particulate air (HEPA) filters and a charcoal adsorber. This system is described and evaluated in detail in Section 6.5.1.

The RAB Normal Ventilation Supply System consists of an outside air intake equipped with a self-acting tornado damper and an evaporative air cooler. The evaporative air cooler includes, in the direction of air flow, a medium efficiency filter, an electric heating coil, an air washer, and

two 100 percent vane-axial fans arranged in parallel (one operating-one standby). Evaporative cooling is typically not used.

Each fan is provided with an inlet and outlet isolation damper to prevent air recirculation through an idle fan. The fan capacity and design data is shown in Table 9.4.3-1. Outside air is drawn through the system and supplied to areas of the RAB including the ground floor (261' el) down to the lower level (190' el) excluding H&V equipment room; air is distributed through a sheet metal ductwork distribution system. Redundant isolation dampers, mounted in series, are provided at each supply ventilation penetration into the areas included in the emergency exhaust system boundary.

In addition to the supply system, the CVCS chiller area and the 480 V auxiliary bus area are cooled by fan coolers. The NNS fan coolers are factory fabricated air handling units; each unit consists of a fan section, cooling coil section and a filter section. Design data for system components are presented in Table 9.4.3-1.

The NNS fan coolers circulate the rooms air across the cooling coil and discharge the cooled air to the space served. Sheet metal ductwork is provided as required to distribute the cooled air.

As indicated on Figures 9.2.8-1 and 9.2.8-2 and described in Section 9.2.8, the chilled water for the cooling coils is supplied from the Essential Chilled Water System.

The RABNVS Exhaust System consists of our subsystems, each having a pneumatic inlet damper, medium efficiency filter, HEPA filter, charcoal adsorber and a centrifugal fan with variable inlet vanes. The exhaust units are arranged in parallel and each fan is provided with a pneumatic inlet damper and a gravity discharge damper to prevent air recirculation through any idle fan during maintenance.

Air is exhausted from the RABNVS through a vent stack located on the roof of the Reactor Auxiliary Building (see Table 9.4.0-2). As in the supply duct system redundant isolation dampers, mounted in series, are provided at each exhaust penetration from the areas included in the emergency exhaust system boundary.

The RAB Normal Exhaust System serves as containment pre-entry purge backup and normal containment purge during normal plant operation. Also, the Pre-Entry Purge System as shown on Figure 6.2.2-3 and described in Section 9.4-7 serves as a standby unit for the RAB Normal Exhaust System.

In the event of an accident or loss of offsite power, the RABNVS will shut down. Air will be exhausted by an independent Emergency Exhaust System.

Air sampling systems in the normal exhaust ducts will detect the radioactivity level as described in Sections 11.5 and 12.3.4.

Upon detection of smoke in the Ventilation System, the supply fans will automatically be tripped to prevent the spread of smoke and reduce the supply of air to the fire in accordance with NFPA 90A.

9.4.3.2.2 RAB NNS ventilation system

The RAB NNS Ventilation System consists of two H&V Equipment Rooms Ventilation Subsystems (north and south). Each subsystem is similar and the north part equipment is tagged with a Z.

The RAB NNS Ventilation System is shown on Figures 9.4.3-1 and 9.4.3-9. Design data for principal system components are presented in Table 9.4.3-1. Each RAB NNS Ventilation Subsystem consists of an outside air intake plenum, medium efficiency filter, electric heating coil, chilled water cooling coil and centrifugal supply and return fans. The system is capable of functioning as a once through or as a mixed (recirculation with makeup) system. The conditioned air is supplied to the H&V equipment rooms through a sheet metal ductwork distribution system.

The chilled water for the cooling coil is supplied from the Essential Services Chilled Water System (ESF water chiller) which is described in Section 9.2.8 and shown on Figures 9.2.8-1, 9.2.8-2, and 9.2.8-3.

Upon detection of smoke in the Ventilation System, the supply fans will automatically be tripped to prevent the spread of smoke and reduce the supply of air to the fire in accordance with NFPA 90A.

9.4.3.2.3 Waste processing areas ventilation system

The Waste Processing Areas Ventilation System is shown on Figures 9.4.3-3, through 9.4.3-8. Design data for principal system components are presented in Table 9.4.3-2. The major part of the ventilation system is a once through type for the contaminated areas. A small portion of the system serving the non-contaminated areas is an economizer cycle which blends outside air and return air as required.

The ventilation system consists of a supply system, a filtered exhaust system for the contaminated areas and a return exhaust system for the non-contaminated areas.

a) Supply System - The supply system for the waste processing areas is shown on Figures 9.4.3-3 through 9.4.3-8 and consists of two evaporative air coolers, arranged in parallel, connected to a common outside intake provided with two intake louvers with bird screens. Each evaporative air cooler includes, in the direction of airflow a medium efficiency filter, electric heating coil, air washer and two 100 percent capacity vane axial fans, arranged in parallel (one operating-one standby). Each fan is provided with an inlet and an outlet isolation damper to prevent air recirculation through an idle fan. A return outside air mixing section with dampers is provided for each evaporative air cooler. Evaporative cooling is typically not used.

   The fans discharge to a common plenum and continuously supply conditioned air to various spaces in the Waste Processing Building through a sheet metal ductwork distribution system.

   In addition to the evaporative air coolers, the supply system is supplemented with 9 recirculation fan coil units and one chilled water booster cooling coil unit which is installed in ductwork. Each fan coil unit includes a medium efficiency filter with screen, a

chilled water cooling coil and a centrifugal fan. Six fan coil units draw air from corridor areas of the Waste Processing Building through the cooling coils and resupply to the corridors through ductwork distribution system. Two fan coil units are located in the chillers room and one is located in the HVAC equipment room for supplementary local cooling. The chilled water booster cooling coil unit is installed in the branch of the supply ductwork serving the Volume Reduction System.

The cooling coils are supplied with chilled water from the Non-essential Services Chilled Water System.

Upon detection of smoke in the Ventilation System, the supply fans will automatically be tripped to prevent the spread of smoke and reduce the supply of air to the fire in accordance with NFPA 90A.

b) Filtered Exhaust System - The Waste Processing Areas Filtered Exhaust System for the contaminated areas is shown on Figure 9.4.3-4 and consists of four filtered subsystems. Each of the subsystems includes, in the direction of airflow, an isolation damper, medium efficiency filter, HEPA filter, charcoal adsorber, automatic isolation damper and a centrifugal fan with variable inlet vanes. A standby fan is furnished for use during maintenance or shutdown of a filtered subsystem. The standby fan is provided with an inlet and outlet isolation damper to prevent air recirculation.

The subsystems are arranged in parallel with gravity dampers at the fan discharge to prevent air recirculation through an idle fan during maintenance of one of the four units. Normally, three of the four exhaust fans are operating.

Air is continuously exhausted from the contaminated areas of the Waste Processing Building via a duct distribution system and discharged to a vent stack located on the roof of the Waste Processing Building.

Constant airflow is maintained and controlled by the variable inlet vanes in conjunction with the Airflow Control System.

c) Non-filtered Exhaust System - The non-filtered exhaust system for the non-contaminated areas in the Waste Processing Building is shown on Figure 9.4.3-6 and consists of three subsystems (one exhaust system and two return exhaust systems). Each subsystem consists of two 100 percent capacity centrifugal fans (one operating-one standby), arranged in parallel. Each fan is provided with an automatic inlet and discharge dampers to prevent air recirculation through an idle fan.

During hot weather conditions, air will be exhausted from the switchgear room, chiller room, HVAC equipment rooms, WPB cooling water pump and heat exchanger areas and elevator machine room to the vent stack located on the roof of WPB.

During cold weather conditions, air from the clean areas such as the switchgear room and the chiller room is returned to the evaporative air cooler and mixed with outside air. Two motorized mixing dampers are provided at the intake of each supply unit to blend outside air and return air from the non-filtered exhaust system.

9.4.3.2.4 WPB Control Room HVAC System

The WPB Control Room HVAC System is shown on Figure 9.4.3-4 and components design data are presented in Table 9.4.3-3. The Control Room HVAC System consists of two 50 percent capacity units, arranged in parallel. Each unit includes, in the direction of airflow, a common outside air intake plenum, a return outside air mixing section with dampers, medium efficiency filters, electric heating coil, chilled water cooling coil, electric reheat coil, and a centrifugal fan with a gravity type discharge damper to prevent air recirculation through the idle fan. Air will be drawn through the system, mixed with the return air and supplied to the WPB Control Room. Normally, one fan is operating. The cooling coil will be supplied with chilled water from the Non-Essential Services Chilled Water System (see Section 9.2.9). Portions of the air will be transferred to the corridor areas and exhausted by the filtered exhaust system of the Waste Processing Areas Ventilation System and the other portion of air will be returned to the air handling units.

Upon detection of smoke in the Ventilation System, the supply fans will automatically be tripped to prevent the spread of smoke and reduce the supply of air to the fire in accordance with NFPA 90A.

9.4.3.2.5 WPB Personnel Handling Facility HVAC System

The WPB Personnel Handling Facility HVAC System is shown on Figure 9.4.3-7. Design data for principal system components are presented in Table 9.4.3-4. The Personnel Handling Facility HVAC supply system consists of an outside air intake plenum, isolation damper, medium efficiency filters, electric heating coil, chilled water cooling coil, and a centrifugal fan with gravity type discharge damper. The conditioned air is supplied to areas such as locker room, monitor areas, operating area, health physics work area, storage, wash rooms, etc. in the Waste Processing Building. Six electric zone reheat coils are located in the supply ducts to maintain proper supply air temperature. Air is exhausted and discharged to a vent stack located on the roof of the WPB by an exhaust fan. The exhaust fan is provided with a gravity type discharge damper.

The cooling coil is supplied with chilled water from the Non-Essential Services Chilled Water System (see Section 9.2.9).

Upon detection of smoke in the Ventilation System, the supply fans will automatically be tripped to prevent the spread of smoke and reduce the supply of air to the fire in accordance with NFPA 90A.

9.4.3.2.6 WPB Office and Laundry Areas HVAC System

The WPB Office and Laundry Areas HVAC System is shown on Figures 9.4.3-7 and 9.4.3-8 and system component design data is presented in Table 9.4.3-5. The Office and Laundry Areas HVAC System consists of three subsystems:

a) Laundry Dryer Supply System

b) Laundry Facility Air Conditioning System

c) Office Areas Air Conditioning System

Each system will be described separately.

a) Laundry Dryer Supply System - The Laundry Dryer Supply System is a once through system; it provides makeup air, heating and ventilating to the cold laundry area. The supply system consists of six supply fans sharing a common outside air intake with a prefilter section and common supply air ductwork. The common outside air intake section consists, in the direction of air flow, a louver with bird screen, a locked-open manual isolation damper, and an air casing with medium efficiency filters. Each fan inlet is connected to the common filter casing through a sheet metal duct. Air is drawn from the filter casing through an isolation damper, an electric heating coil and a gravity discharge damper. Air is supplied to the cold laundry room through two sheet metal supply ducts.

   Air from each of the six dryers is exhausted by an external booster fan and discharged through a common duct to the vent stack located on the roof of the WPB. An additional exhaust fan is used to exhaust the surplus air to the discharge vent stack.

b) Laundry Facility Air Conditioning System - The Laundry Facility Air Conditioning System is a once through system. The system consists of an air handling unit and a zone reheat coil. The air handling unit draws 100 percent outside air and supplies air to the hot and cold laundry area and HVAC equipment room. The electric zone reheat coil in the supply duct will maintain proper space temperature.

   The air handling unit includes, in the direction of airflow, an isolation damper, a medium efficiency filter, an electric heating coil, a chilled water cooling coil, and a centrifugal fan with a gravity type discharge damper. The cooling coil of the air handling unit is supplied with chilled water from the Non-Essential Services Chilled Water System (see Section 9.2.9).

   Air from the hot and cold laundry area is exhausted and discharged to the vent stack on the roof by an exhaust fan. The exhaust fan is provided with a gravity type discharge damper.

   Upon detection of smoke in the Ventilation System, the supply fans will automatically be tripped to prevent the spread of smoke and reduce the supply of air to the fire in accordance with NFPA 90A.

c) Office Area Air Conditioning System - Major equipment for the Office Area Air Conditioning System consists of an air handling unit, a recirculating fan and seven electric zone reheat coils. The air handling unit includes, in the direction of airflow, a mixing section with two automatic dampers, a medium efficiency filter, an electric heating coil, a chilled water cooling coil, and a centrifugal fan with a discharge gravity damper. The cooling coil is supplied with chilled water from the non-Essential Services Chilled Water System (see Section 9.2.9). Three electric zone reheat coils located in the supply ducts will maintain proper space temperature.

   During normal condition, a portion of the air from the office areas is returned to the air handling unit and mixed with the outside air for recirculation. During an abnormal condition, such as smoke, air from the office areas will be exhausted and discharged to

the vent stack. An exhaust fan with an automatic damper, located in the branch exhaust duct, is provided for this purpose.

Upon detection of smoke in the Ventilation System, the supply fans will automatically be tripped to prevent the spread of smoke and reduce the supply of air to the fire in accordance with NFPA 90A.

9.4.3.2.7 WPB Laboratory Areas HVAC System

The WPB Laboratory Areas HVAC System is shown on Figure 9.4.3-8. Design data for principal system components are presented in Table 9.4.3-6.

The Laboratory Areas HVAC Supply System consists of three supply units for all the fume hoods and an air handling unit for laboratory areas. Each fume hood supply unit includes, in the direction of airflow, an isolation damper, medium efficiency filters, an electric heating coil and a centrifugal fan with an automatic recirculating discharge damper. The air handling unit includes an isolation damper, a medium efficiency filter, electric heating coil, chilled water cooling coil and a centrifugal fan with a gravity discharge damper.

Four electric zone reheat coils are located in the supply ducts of the air conditioning system to maintain proper supply air temperature.

Air from the laboratory areas is exhausted and discharged to the vent stack located on the roof of the WPB by exhaust fans. Each exhaust fan is provided with a gravity discharge damper.

Each fume hood is provided with an exhaust fan and air is discharged to the vent stack located on the roof of the WPB. Each exhaust fan is provided with an automatic inlet damper and a gravity discharge damper. Two fume hoods are provided with a medium efficiency prefilter and a HEPA filter.

Upon detection of smoke in the Ventilation System, the supply fans will automatically be tripped to prevent the spread of smoke and reduce the supply of air to the fire in accordance with NFPA 90A.

The cooling coil of the air handling unit is supplied with chilled water from the Non-Essential Services Chilled Water System (see Section 9.2.9).

9.4.3.2.8 WPB I&C Shop HVAC System

(Note: This area is no longer being used as an I&C Shop but the system description is valid.) The WPB I&C Shop HVAC System is shown on Figure 9.4.3-6. Design data for principal system components are presented in Table 9.4.3-7. The HVAC System consists of an air handling unit which draws air from the outside through an isolation damper, medium efficiency filters, an electric heating coil, a chilled water cooling coil, and a centrifugal fan followed by an electric reheat coil. Air will be transferred to the cooling water pump area stair and sample room and exhausted through the Non-filtered Exhaust System of the Waste Processing Areas Ventilation System.

The cooling coil of the air handling unit is supplied with chilled water from the Non-essential Services Chilled Water System (see Section 9.2.9).

Upon detection of smoke in the Ventilation System, the supply fans will automatically be tripped to prevent the spread of smoke and reduce the supply of air to the fire in accordance with NFPA 90A.

9.4.3.3 Safety Evaluation

9.4.3.3.1 RAB Normal Ventilation System

Isolation dampers at the RAB emergency exhaust boundary located in the normal ventilation supply and exhaust ductwork are safety related and designated as Safety Class 3 and Seismic Category I. Upon receipt of a Safety Injection Actuation Signal (SIAS) or a Control Room Isolation Signal (CRIS), the isolation dampers will close to prevent potential release of radioactivity from these areas and the RAB Emergency Exhaust System will be energized automatically.

The Reactor Auxiliary Building Normal Ventilation System (supply and exhaust systems), except for the isolation dampers and associated ductwork, is not required to operate during accident conditions.

System duct penetrations to areas containing equipment essential for safe shutdown have been located to prevent radiation streaming into normally accessible areas. Where required, additional shielding at penetrations is provided.

9.4.3.3.2 RAB NNS-Ventilation System

The RAB NNS Ventilation System is not safety related. The system will not be required to operate during accident conditions.

9.4.3.3.3 Waste Processing Building HVAC Systems

None of the HVAC Systems in the Waste Processing Building are safety related. The systems will not be required to operate during accident conditions. Upon a loss of power, all the HVAC Systems will shut down.

9.4.3.4 Inspection and Testing Requirements

Refer to Section 14.2.12 for a discussion of preoperational and startup testing provisions applicable to the Reactor Auxiliary Building Ventilation Systems and Waste Processing Building HVAC Systems. Inservice testing will be in accordance with the manufacturer's recommendations. Also, refer to Section 1.8 for applicable Regulatory Guide requirements.

9.4.4 TURBINE BUILDING AREA VENTILATION SYSTEM

The Turbine Building Area Ventilation System consists of the following systems:

a) Condensate Polishing Demineralizers Area Ventilation System, which provides heating and ventilation for spaces in condensate polishing demineralizer areas, corridor areas, and H&V equipment room. Refer to Sections 9.4.4.1.1 and 9.4.4.2.1 for a detailed discussion.

b) Electrical and Battery Room Ventilation System, which provides heating and ventilation for electrical equipment room and battery room. Refer to Sections 9.4.4.1.2 and 9.4.4.2.2 for a detailed discussion.

c) General Service Switchgear Room Ventilation System which provides heating and ventilation for the switchgear room in Turbine Building. Refer to Sections 9.4.4.1.3 and 9.4.4.2.3 for a detailed discussion.

d) Deleted in Amendment 62.

e) Elevator Machinery Room Ventilation System and Sampling Room HVAC System which provide ventilation and heating for elevator machinery room and heating and ventilation for the Secondary Sampling Room. Refer to Sections 9.4.4.1.5 and 9.4.4.2.5 for a detailed discussion.

f) Secondary Sampling Equipment Enclosure System which provides cooling for the secondary sampling equipment enclosure. Refer to Sections 9.4.4.1.6 and 9.4.4.2.6 for a detailed discussion.

9.4.4.1 Design Bases

9.4.4.1.1 Condensate polishing demineralizer area ventilation system

The Condensate Polishing Demineralizer Area Ventilation System is designed:

a) To provide normal ventilation to maintain a controlled environment suitable for plant personnel and continuous operation of systems and equipment.

b) To direct air from areas of low potential radioactivity to areas of progressively higher potential radioactivity.

c) To monitor, detect and control the release of airborne radioactivity for the ventilation system discharge (see Sections 11.5 and 12.3.4).

d) To provide sufficient redundancy in the normal supply and exhaust systems to ensure continuous reliable performance during normal operations.

e) To provide a direct exhaust from the secondary sampling panels during sample operations.

9.4.4.1.2 Electrical and battery rooms ventilation system

The Electrical and Battery Rooms Ventilation System is designed:

a) To provide normal heating and ventilating to maintain a controlled environment suitable for plant personnel and continuous operation of electrical equipment.

b) To provide separate exhaust for the Battery Room.

c) To provide sufficient redundancy in the supply and exhaust systems to ensure continuous reliable performance during normal operations.

9.4.4.1.3 General Service Switchgear Room and Cable Spreading Room Ventilation System

The General Design Switchgear Room and Cable Spreading Room Ventilation System is designed:

a) To provide normal ventilation to maintain a controlled environment suitable for plant personnel and continuous operation of systems and electrical equipment.

b) To provide sufficient redundancy in the normal supply system to ensure continuous reliable performance during normal operation.

9.4.4.1.4 Deleted in Amendment 62

9.4.4.1.5 Elevator Machine Room Ventilation System and Sampling Room HVAC System

The Elevator Machine Room Ventilation System is designed to provide normal ventilation and maintain a controlled environment suitable for continuous operation of systems and equipment.

The Sampling Room HVAC System is designed to provide heating and ventilation to a controlled environment to assure continuous operation of systems and equipment.

9.4.4.1.6 Secondary Sampling Equipment Enclosure System

The Secondary Sampling Equipment Enclosure System is designed to maintain habitable conditions for personnel working in the enclosure and to maintain room temperature conditions required by the LEFM Electronics unit.

9.4.4.2 System Description

9.4.4.2.1 Condensate Polishing Demineralizer Area Ventilation System

The Condensate Polishing Demineralizer Area Ventilation System is shown on Figure 9.4.4-1. Design data for principal system components are presented in Table 9.4.4-1. The ventilation system is a once-through type and consists of a supply system and a filtered exhaust system.

a) Supply System - The supply system consists of an outside air intake louver with bird screen and evaporative air cooler. The evaporative air cooler includes, in the direction of airflow, a pneumatic damper, a medium efficiency filter, an electric heating coil and two 100 percent capacity centrifugal fans, arranged in parallel (one operating one standby). Each fan is provided with a pneumatic inlet damper and discharge damper to prevent air recirculation through the idle fan.

   The fan inlets are connected to a common plenum and air is drawn from outside through the system and continuously supplied to the condensate polishing demineralizer areas, corridor areas and H&V Equipment Room through a sheet metal ductwork distribution system.

Upon detection of smoke in the Ventilation System, the supply fans will automatically be tripped to prevent the spread of smoke and reduce the supply of air to the fire in accordance with NFPA 90A.

b) Filtered Exhaust System - The Condensate Polishing Demineralizer Areas Exhaust System consists of a filtered exhaust unit. The exhaust unit includes, in the direction of air-flow, a medium efficiency filter, HEPA filter, charcoal adsorber, and two 100 percent capacity centrifugal fans, arranged in parallel (one operating - one standby). Each fan is provided with variable inlet vanes and a pneumatic discharge damper to prevent air recirculation through the idle fan.

Air is continuously exhausted from the potentially contaminated spaces of the condensate polishing demineralizer area, through the filter system and discharged to the turbine building vent stack shown on Figures 1.2.2-72, 1.2.2-76, and 9.4.4-1. The discharges of the turbine building vent stack are monitored by a wide range noble gas monitor described in Section 11.5.2 and shown on Figure 9.4.4-1.

A bypass duct with pneumatic isolation dampers is provided for the filtration system so that during maintenance of filters, charcoal adsorber and HEPA filter air can be continuously exhausted from condensate polishing demineralizer areas.

c) Air conditioning is provided for the Secondary Sampling System in a separate enclosure. Air is directly exhausted from the sampling panels to the Condensate Polishing Demineralizer Area Exhaust System during sampling operations.

9.4.4.2.2 Electrical and Battery Room Ventilation System

The Electrical and Battery Room Ventilation System is shown on Figure 9.4.4-1. Design data for principal system components are presented in Table 9.4.4-2. The ventilation system is a once-through type during summer operation and, a major part of the system for the electrical equipment room is an economizer cycle type during winter season. The Electrical and Battery Room Ventilation System consists of a supply unit and a separate exhaust unit for the battery room.

The supply unit includes, in the direction of airflow, an outside air intake louver with bird screen, an automatic isolation damper, a medium efficiency filter, an electric heating coil and two 100 percent capacity centrifugal fans, arranged in parallel (one operating - one standby). Each fan is provided with a pneumatic discharge damper to prevent air recirculation through the idle fan. Air is drawn from outside through the air handling unit and supplied to the electrical equipment room and battery room.

A separate exhaust system is provided for the battery room and air from the electrical equipment room is discharged to atmosphere through louvers. The exhaust system for the battery room consists of two 100 percent, centrifugal fans (one operating - one standby), with automatic pneumatic inlet dampers to prevent air recirculation through the idle fan. In addition, a separate zone electric re-heat coil is provided in the air supply duct of the battery room ventilation system to maintain proper supply air temperature. A large portion of air from the electrical equipment room is returned to the air handling unit for recirculation during winter conditions.

Upon detection of smoke in the Ventilation System, the supply fans will automatically be tripped to prevent the spread of smoke and reduce the supply of air to the fire in accordance with NFPA 90A.

9.4.4.2.3 General service switchgear room and cable spreading room ventilation system

The General Service Switchgear Room and Cable Spreading Room Vault Ventilation System is shown on Figure 9.4.4-1. Design data for principal system components are presented in Table 9.4.4-3. The ventilation system for the general service switchgear room will be a once-through type, a recycled air type, or a combination of the two dependent upon air duct temperature. The ventilation system consists of a supply unit which includes in the direction of airflow, an outside air intake louver with bird screen, an automatic isolation damper, a medium efficiency filter, an electric heating coil and two 100 percent capacity fans arranged in parallel (one operating - one standby). Each fan is provided with a discharge isolation damper to prevent air recirculation.

Air is supplied to the switchgear room and discharged to the atmosphere through air-operated dampers. Each louver is provided with an automatic damper. Some air from the switchgear room is returned to the air handling unit for recirculation as air duct temperature decreases.

The cable spreading room is ventilated by the same supply unit of the switchgear ventilation system. Air is supplied to the area and discharged to the atmosphere through a louver located in the switchgear room with ductwork connection.

9.4.4.2.4 Deleted per Amendment 62

9.4.4.2.5 Elevator machine room and Sampling Room Ventilation System

The Elevator Machine Room Ventilation System is shown on Figure 9.4.4-1. The Ventilation System consists of a sidewall fan with backdraft damper; two filtered outside air intake louvers with backdraft dampers; and an electric unit heater. In the summer, a thermostat energizes the fan, which draws air through the louver dampers and discharges it to the outside. In the winter seasons, supplementary heating is provided by an electrical unit heater located in the elevator machine room.

The Sampling Room HVAC System consists of electric wall fin heaters and a wall exhaust fan.

In the winter seasons, the sampling room is heated by an, electric wall fin heater and ventilation air is drawn in from outside through louvers by a wall exhaust fan.

Design data for the Elevator Machine Room Ventilation System and the Sampling Room HVAC System are shown in Table 9.4.4-5.

9.4.4.2.6 Secondary sampling equipment enclosure system

The Secondary Sampling Equipment Enclosure System consists of two four ton split system air conditioning units. The condensing units are on elevation 261' of the Turbine Building. The air handlers are mounted above the enclosure, which is on elevation 240' of the Turbine Building. The two four ton air conditioning units start in sequence according to the demand of the thermostat. They operate in a recirculation mode.

Design data for the Secondary Sampling Equipment System is shown in Table 9.4.4-6.

9.4.4.3 Safety Evaluation

The Turbine Building Area Ventilation Systems are not safety related. The systems will not be required to operate during accident conditions. Upon a loss of power, the ventilation systems will shut down.

9.4.4.4 Inspection and Testing Requirements

Refer to Section 14.2 for a discussion of testing provisions as they apply to the Turbine Building HVAC Systems. Also, refer to Section 1.8 for applicable Regulatory Guide requirements.

9.4.5 ENGINEERED SAFETY FEATURE VENTILATION SYSTEM

The Engineered Safety Feature Ventilation System consists of the following systems:

a) Reactor Auxiliary Building ESF Equipment Cooling System

b) Reactor Auxiliary Building Switchgear Rooms Ventilation System

c) Reactor Auxiliary Building Electrical Equipment Protection Room Ventilation System.

d) Fuel Oil Transfer Pump House Ventilation System

e) Diesel Generator Building Ventilation System

f) Emergency Service Water Intake Structure Ventilation System

g) Spent Fuel Pump Room Ventilation System (see Section 9.4.2)

9.4.5.1 Design Bases

9.4.5.1.1 Reactor Auxiliary Building ESF Equipment Cooling System

The Reactor Auxiliary Building ESF Equipment Cooling System is designed to:

a) Serve all areas containing equipment essential for safe shutdown

b) Maintain space temperatures at or below electrical equipment design temperature of 104 F for all areas containing essential equipment which operate during safe shutdown. The ESF fan coolers start on a temperature rise due to start-up of the essential equipment contained in the corresponding areas.

c) Meet Safety Class 3 and Seismic Category I requirements.

d) Provide sufficient redundancy to meet the single active failure criterion.

e) Permit periodic testing and inspection of principal components.

9.4.5.1.2 Reactor Auxiliary Building Switchgear Rooms Ventilation System

The Reactor Auxiliary Building Switchgear Rooms Ventilation System (RABSRVS) will be designed to:

a) Maintain a controlled environment in all served areas to assure suitable operating conditions for plant personnel and continuous operation of vital systems and equipment for indoor space temperatures (see Table 9.4.0-1).

b) Maintain airflow from areas of low potential contamination to areas of progressively higher potential contamination.

c) Exhaust sufficient air from the battery rooms served, by the RABSRVS, to prevent the accumulation of combustible concentrations of hydrogen.

d) Provide sufficient redundancy to meet the single active failure criterion.

e) Meet Safety Class 3 and Seismic Category I requirements

f) Permit testing and inspection of principal components prior to start up and on a regular basis to assure system integrity and functional capability.

9.4.5.1.3 Reactor Auxiliary Building Electrical Equipment Protection Room Ventilation System

The Reactor Auxiliary Building Electric Equipment Protection Room Ventilation System (RABEEPRVS) is designed to:

a) Maintain suitable ambient conditions for personnel comfort and safety. The system maintains all involved area temperatures as required to assure proper operation of vital systems and equipment.

b) Provide sufficient redundancy to meet the single active failure criterion.

c) Meet Safety Class 3 and Seismic Category I requirements.

d) Permit testing and inspection of principal components prior to start-up and on regular basis to assure system integrity and functional capability.

9.4.5.1.4 Fuel Oil Transfer Pump House Ventilation System

The Fuel Oil Transfer Pump House Ventilation System is designed to:

a) Provide ventilation for Fuel Oil Transfer Pump Room to remove diesel fuel fumes.

b) Provide sufficient ventilation redundancy to meet the single active failure criterion.

c) Provide redundant trains A and B powered by separate safety buses such that failure of a single active component failure cannot result in a complete loss of any engineered safety features system function.

d) Meet Safety Class 3 and Seismic Category I requirements.

e) Permit periodic testing and inspection of principal system components.

9.4.5.1.5 Diesel generator building ventilation system

a) Maintain the temperature in the diesel generator rooms at maximum of 120 F whenever the diesel generators are in operation.

b) Maintain the temperature in the electrical equipment room and fan room at a maximum of 116 F and 118 F respectively for protection of electric equipment and motors.

c) Provide redundant trains A and B powered by separate safety buses such that failure of a single active component cannot result in a complete loss of any system function.

d) Remain functional during and after a Safe Shutdown Earthquake (SSE).

e) Meet Safety Class 3 and Seismic Category I requirements.

f) Permit periodic testing and inspection of principal system components.

9.4.5.1.6 Emergency Service Water Intake Structure Ventilation System

The Emergency Service Water Intake Structure Ventilation System is designed to:

a) Maintain the temperature in the electrical MCC room at a maximum of 116 F and Emergency Pump Room at a maximum of 122 F.

b) Meet Safety Class 3 and Seismic Category I requirements.

c) Permit periodic testing and inspection of principal components.

d) Provide redundant trains A and B powered by separate safety buses such that failure of a single active component cannot result in a complete loss of any engineered safety feature system function.

9.4.5.2 Systems Description

9.4.5.2.1 Reactor Auxiliary Building ESF Equipment Cooling System

The RAB ESF Equipment Cooling System consists of a) Cooling Systems for various ESF equipment areas and b) Steam Tunnel Ventilation System.

a) The cooling systems consist of factory fabricated air handling units. Each unit consists of a fan section, a cooling coil section and a filter section. The system components design data are presented in Table 9.4.5-1. Chilled water for the cooling coils is supplied from the Essential Services Chilled Water System as shown on Figures 9.2.8-1, 9.2.8-2, and 9.2.8-3.

   The following areas are served by fan coolers:

1) Containment spray and RHR pump area.

2) Component cooling pumps and heat exchanger area.

3) Charging pump areas.

4) Mechanical and electrical penetration areas.

5) Auxiliary feedwater piping and valve area.

6) Service water booster pump area.

7) Switchgear and Control Rooms.

8) H&V equipment room.

9) Containment spray tank, boron injection tank and pump, component cooling water drain tank and pump area.

10) RAB MCC Area.

11) Rod Control Cabinet Room.

12) HV Penetration Area

The Reactor Auxiliary Building ESF Equipment Cooling System is shown on Figures 9.4.3-1 and 9.4.3-2. Also Figure 9.4.5-1 (AH-93).

Air is drawn from each room through the fan cooler and discharged to the space it serves. Discharge ductwork will be provided to distribute the cooled air.

The HV Penetration Area which houses the Reactor Vessel Level Indicating System rack receives cooling air post-accident from the Mechanical Penetration Area located adjacent to the space. A safety-related fan and Seismic Category I ductwork are used to transfer air from the Mechanical Penetration Area which is cooled by safety-related fan coolers. The air is recirculated through a door opening back to the fan cooler.

b) The Steam Tunnel Ventilation System is shown on Figure 9.4.3-2 and system components design data are presented in Table 9.4.5-2. The Steam Tunnel Ventilation System consists of two vaneaxial in line fans with independent ductwork and louvers.

During normal condition, one fan will start when the outdoor temperature is 43°F and above; the second fan will start when the outdoor temperature is 70°F and above. Air is drawn from outside through louvers and supplied to the steam tunnel through a ductwork distribution system.

The steam tunnel fans may be manually operated through individual control switches in the Main Control Room. Manual control may be necessary during extreme cold or warm weather temperatures.

9.4.5.2.2 Reactor Auxiliary Building Switchgear Rooms Ventilation System

The Reactor Auxiliary Building Switchgear Rooms Ventilation System is shown on Figure 9.4.5-1 and components design data are presented in Table 9.4.5-3.

The Reactor Auxiliary Building has two switchgear rooms. Each switchgear room has its own independent air conditioning system. Switchgear Switchgear Room A air conditioning system is connected to safety channel A, and Switchgear Room B air conditioning system is connected to safety channel B.

Each RABSRVS, consists of a missile protected air intake, (the "A" RABSRVS is equipped with a tornado resistant personnel hatch and the "B" RABSRVS is equipped with a self-acting tornado damper), medium efficiency filter, electric heating coil, two 100 percent redundant chilled water cooling coils connected in series and two 100 percent redundant centrifugal fans arranged in parallel. Each fan is provided with a motorized inlet damper and a gravity discharge damper to prevent air recirculation through the idle fan. One fan is normally operating and the other fan is on standby. The outside air intake valves (AC-D3SA-1 and AC-D5SB-1) are de-energized closed to ensure that the switchgear room will not become pressurized. This pressurization could adversely impact the required pressurization of the control room to all adjacent areas. Air is supplied to the areas served through a sheet metal ductwork distribution system. The Auxiliary Control Panel Room, which is normally ventilated by the Switchgear Room "B" system, has a provision for a redundant ventilation from the Switchgear Room "A" system.

The battery room exhaust system consists of two 100 percent capacity redundant fans. Each fan is provided with a gravity discharge damper to prevent air recirculation through the idle fan. Air is discharged to the atmosphere through a missile protected tornado damper. Sufficient air will be exhausted from each battery room of the switchgear room areas to prevent the accumulation of combustible concentrations of hydrogen.

During normal operation, when AH-12/E-28 and AH-13/E-29 operate, the ventilation system is capable of maintaining the hydrogen gas concentration in the battery rooms well below the specified limits (2% volume). During this mode, the ventilation system permits the introduction of at least 300 CFM and the continuous purging by the exhaust system of the battery room. Hydrogen cannot build up to excessive levels due to the relatively high dilution rate.

During the post-LOCA mode of operation, upon generation of a control room isolation signal, the ventilation system reverts to 100% recirculation with the exhaust fans off. During this mode, hydrogen is distributed through over 250,000 cubic feet of space. The calculated time of maximum hydrogen build up (2% volume) will be reached in 32 days in the Switchgear Room (train "A") and in 64 days in the Rod Control Cabinet Room (train "B").

The RABSRVS supply fans and the battery room exhaust fans are supplied with onsite emergency power from the diesel generator in the event of loss of offsite power. The chilled water for cooling coils of air handling units is supplied from the Essential Services Chilled Water System as described in Section 9.2.8 and shown on Figures 9.2.8-1, 9.2.8-2, and 9.2.8-3.

PIC Room "A" Standby Cooling System (FCC-1 and ACC-1)

The Process Instrument Cabinet (PIC) Room "A" standby cooling system was installed to serve as a backup to the normal ventilation system that provides ventilation to the room and maintains its temperature. It is postulated that the normal ventilation system will be lost as a result of certain fire scenarios that cause fire damper(s) in the normal ventilation ducts to fail closed.

The standby cooling system consists of a fan cooler unit (FCC-1), located in the area just east of PIC Room "A", and an air-cooled condenser (ACC-1) located on the roof of the RAB. The FCC-1 contains a fan and the evaporator coil. When the system is operating, the FCC-1 fan circulates cool air to the PIC "A" Room. At the same time the fan in the FCC starts, a fan in the condenser unit (ACC-1) also starts. A temperature switch (TS-6596) located within PIC Room "A" automatically starts the system when the temperature in the room reaches 82 F, and secures the system when the temperature reaches 72 F.

The system is normally in service, but will not operate unless the temperature in the room reaches 82 F. When the room temperature reaches 82 F the system will automatically start and circulate cooler air to the room. When the PIC room temperature reaches 72 F, the system will automatically stop. This configuration will ensure that the system will automatically start in the event fire interrupts normal ventilation to the room.

Smoke Purge Operation

Provisions have been made for once through smoke purge for all areas that are normally recirculated (i.e., during the normal operation the supplied air is continuously recirculated). These areas are:

1. Cable Spreading Rooms - "A" and "B"

2. Switchgear Rooms - "A" and "B"

3. Rod Control Cabinets Room and Stairs - "B"

In the event of smoke in one of these areas the smoke detectors located in the common return air duct and the outside air intake may actuate an alarm in the Control Room for operator action and automatically shut down the fans. During this temporary shutdown of the normal air conditioning in areas served by train "A", cooling will not be lost to the Process Instrument Cabinet Room "A" which houses safety-related cabinets. A thermostat located in the space will automatically energize the split system air conditioning provided as a back-up system to maintain cooling for the auxiliary electrical equipment room A297 (PIC cabinet). The operator may remotely activate the smoke purging when smoke is indicated in the common return air duct by manually changing the operational status of valves, dampers, fans and the corresponding air flow rates according to those indicated on Figure 9.4.5-1. Thus the normal recirculated mode of each ventilated area will be changed to a once through pattern as follows:

1. The Cable Spreading Room Smoke Purge ("A" or "B") will be accomplished manually by the operator in the Control Room by starting the normally inactive smoke purge supply and exhaust fans and setting the dampers for once through air path flow by closing return air damper and fully opening intake dampers and exhaust dampers.

2. The Switchgear Room Smoke Purge ("A" or "B") will be initiated by opening the valved roof vents, closing the return air damper and opening of the outside air damper for additional make-up air. The smoke will be expelled through the roof vents by a positive pressure generated by the operating fan of an air handling unit. Each roof vent is protected by a missile and weather proof enclosure.

3. Rod Control Cabinets Room ("B") smoke purge is accomplished by activation of the Switchgear Room B smoke purge system discussed is section 2 above or by convective purging via a valved roof vent in the Rod Control Cabinets Room. Smoke dampers will automatically close to isolate the Rod Control Cabinets Room from the Switchgear Room B ventilation system in the event of smoke in the Rod Control Cabinets Room or Switchgear Room B. This is done to prevent the spread of smoke to unaffected areas via the interconnected HVAC system. Smoke purge by means of the Switchgear Room B smoke purge system will require bypassing the affected fire zone alarm to automatically open the smoke dampers and provide a purge path. Smoke purge by means of the Rod Control Cabinets Room roof vent will initiate automatically upon detection of smoke in the Rod Control Cabinets Room.

   In order to prevent the propagation of smoke by means of the ductwork to spaces not affected by smoke, the smoke purge operation will be started in all the areas. It should be noted that when smoke originates in the Cable Spreading Rooms only the Smoke Purge System associated with it need be activated and the Switchgear Room smoke purge can be left inactive. However, when smoke originates in the Switchgear Room, both the Cable Spreading Rooms and Switchgear Room smoke purge systems must be activated. Valve and damper position indicating lights allow continuous monitoring of system performance and confirm all remote manual control actions.

   It should be noted that the following spaces have continuous once through ventilation system in the event of smoke. The operational status of valves, damper and fans will not be changed:

   1. Battery Rooms

   2. HV and Electrical Equipment Rooms

   3. Auxiliary Control Panel Room

9.4.5.2.3 Reactor Auxiliary Building Electrical Equipment Protection Room Ventilation System

The Reactor Auxiliary Building Electrical Equipment Protection Room Ventilation System is shown on Figure 9.4.5-1 and component design data are presented in Table 9.4.5-4.

The Reactor Auxiliary Electrical Equipment Protection Room Ventilation System has two 100 percent redundant trains that share the same duct work.

The Reactor Auxiliary Building Electrical Equipment Protection Room Ventilation System consists of two 100 percent capacity subsystems in parallel (one-operating and one-standby). Each subsystem is powered by its respective safety channel.

Each ventilation supply subsystem consists of a motorized inlet damper, medium efficiency filter, chilled water cooling coil, supply fan, gravity damper and electric heating coil. The conditioned air is supplied to the areas served through a sheet metal ductwork distribution system. Both ventilation supply subsystems are connected to a common missile protected outside air intake with tornado damper and two motorized butterfly isolation valves in series.

The exhaust system consists of 100 percent capacity redundant fans. Each fan is provided with a back draft discharge damper to prevent air recirculation through an idle fan. The exhausted air is discharged to the atmosphere through a missile protected valve.

During normal operation, a small portion of outside air is drawn through the system mixed with large portion of return air and supplied to the served areas through a sheet metal ductwork distribution system. During LOCA condition all air is recirculated through the system.

The RAB electric equipment protection rooms ventilation supply and exhaust systems are supplied with emergency power from the diesel generators in the event of loss of offsite power.

The cooling coils are supplied with chilled water from the Essential Services Chilled Water System as described in Section 9.2.8 and shown on Figures 9.2.8-1, 9.2.8-2, and 9.2.8-3.

Smoke Purge Operation

In the event of fire in any area of the equipment protection rooms, smoke detectors located in the common return air ducts of air handling system unit, will actuate an alarm for operator action. The operator may remote-manually execute the smoke purge operation by changing the operational status of valves, dampers and fans and the corresponding air flow rates according to those indicated on Figure 9.4.5-1. Thus, the normal ventilation supply system and the smoke purge exhaust system operates in a once through pattern during smoke purge operation.

Valve and damper position-indication lights will allow continuous monitoring of the system performance and will confirm all remote manual control actions taken.

9.4.5.2.4 Fuel Oil Transfer Pump House Ventilation System

The Fuel Oil Transfer Pump House Ventilation System is shown on Figure 9.4.5 2. Design Data for principal system components are presented in Table 9.4.5-5.

The Fuel Oil Transfer Pump House Ventilation System consists of two exhaust subsystems for two pump rooms. Each subsystem consists of two redundant 100 percent capacity exhaust fans. Each fan is provided with a gravity discharge damper to prevent reverse airflow through the inactive fan. One missile protected outside air intake structure and one missile protected air discharge structure located on the roof are provided for the ventilation systems.

Air is drawn from outside through the corridor and transferred to the pump room. A fire damper is provided for each transfer air opening between the corridor and pump room.

Exhaust fans discharge air to the missile protected air discharge structure through sheet metal ductwork. Four unit heaters located in the corridor, maintain the pump room temperature at a nominal 57°F during the winter. The ventilation system is capable of operation during normal and emergency conditions.

9.4.5.2.5 Diesel generator building ventilation system

The following description, although written for the Diesel Generator Building Unit-1A, is equally applicable to Diesel Generator Building Unit 1B.

The Diesel Generator Building Ventilation System is shown on Figure 9.4.5-2. Design data for system principal components are presented on Table 9.4.5-6. Each Diesel Generator Building Ventilation System consists of the following systems:

1. Diesel Generator Room Ventilation System
2. Electrical Equipment Room Ventilation System
3. Fuel Oil Day Tank and Exhaust Silencer Room Ventilation System
4. Air Start System and Axial Fan Area Ventilation System
5. HVAC Equipment Room Ventilation System

9.4.5.2.5.1 Diesel generator room ventilation system

The Diesel Generator Ventilation System consists of two in-line vaneaxial exhaust fans E 86 (1A-SA) and E-86 (1B-SB). Each fan is provided with a gravity discharge damper. Under normal operating conditions, fan E-86 (1A-SA) will automatically start when the diesel generator starts. During an emergency start condition, fan E-86 (1A-SA) will start via the load sequencer which occurs 10-20 seconds after the diesel starts. Under normal conditions, when the diesel generator is running, the second fan, E-86 (1B-SA), will automatically start should either the outside air temperature exceed 80 F or the diesel room temperature exceeds 105 F. During emergency start conditions, this will occur only after receiving a start permissive via the load sequencer which occurs approximately 60 seconds after the diesel start. Air is drawn from outside through louvers, and filters, AH-99 and AH-100 routed to various building areas as shown on Figure 9.4.5-2, and discharged to the outside via the exhaust fan plenum.

The diesel generator building ventilation system incorporates a filtered once-through ventilation system which circulates air at a low velocity so as not to entrain dust within the room nor draw any deleterious material from outside.

The outside air for the diesel generator room will be filtered by a filter bank of fiberglass filter cells in a wall plenum. Air intake into the diesel generator room will be through a labyrinth. Access platforms are provided for filter system inspection and maintenance. Pressure differential indicators are provided for measurement of the pressure drop to indicate when the filters are becoming clogged. Visual inspection will be provided on a monthly basis or when the diesel engine is operated.

When the diesel generator is not in operation, the diesel generator room will be ventilated by the diesel generator room exhaust fan (E-61, Figure 9.4.5-2).

Heating for the diesel generator room, HVAC equipment room and axial fan room is provided by electric unit heaters as shown on Figure 9.4.5-2.

9.4.5.2.5.2 Electric equipment room ventilation system

The Electric Equipment Room Ventilation System consists of an air handling unit with medium efficiency filters, electric heating coil, and two centrifugal fans, AH-85 (1A-SA) and AH-85 (1B-SA). Each fan is provided with a manual shut-off inlet damper and a gravity discharge damper. One fan is continuously operating and the standby fan will automatically start in case of failure of the operating fan.

The damper arrangements for temperature controls in the electric equipment room are as follows:

1. When the outside air temperature is below 70 F and the room temperature is below 95°F, the return air damper DG-D3(SA-1) is locked fully open and the outside air damper DG-D4(SA-1) will be in its minimum open position.

2. Upon detection of smoke in the ventilation system, the supply fans will automatically be tripped to prevent the spread of smoke and reduce the supply of air to the fire in accordance with NFPA 90A. The operator can manually initiate smoke purge by starting E-86 (1A-SA) and E-86 (1B-SA) and fully opening the outside air damper and restarting the supply fan if tripped.

3. When the outside air temperature is above 70°F or the room temperature is above 95°F, the return air damper DG-D3 (SA-1) is locked fully open and the outside air damper will be fully opened.

4. In case of a power failure the outside air damper will fail fully open.

5. When the room air temperature is 70°F or less, the supply air temperature to the room will be maintained at 70°F nominal by the electric heating coil, EHC 119 SN.

6. The room temperature at or above 112°F will be annunciated.

The ventilation system for the electrical equipment room is designed to filter and pressurize the air space for the purpose of limiting dust accumulation.

9.4.5.2.5.3 Fuel Oil Day Tank and Silencer Room Ventilation System

The system consists of two centrifugal exhaust fans with the associated manual dampers and gravity dampers. Fan E-61(1A-SA) is continuously operating and fan E-61 (1B-SA) is on standby. The standby fan is automatically started in case of failure of the operating fan.

Air is transferred to the silencer room from the HVAC equipment room and to the fuel oil tank room from the access corridor.

When the diesel generator is not operating, the damper in the exhaust duct of the silencer room DG-D1(SA-1) is in its minimum open position and the damper in the exhaust duct of diesel room DG-D2(SA-1) is in the fully open position.

Upon start-up of the diesel-generator, the damper, DG-D1(SA-1) will be fully open and the other damper, DG-D2(SA-1), will be fully closed. In the event of a power failure, the damper, DG-D1(SA-1), will fail open and the damper, DG-D2(SA-1), will fail closed.

9.4.5.2.5.4 Air Start System and Axial Fan Area Ventilation System

The ventilation system for this area contains the vaneaxial exhaust fans E86 (1A-SA) and E86 (1B-SA) and associated dampers as described in Subsection 9.4.5.2.1 for the diesel generator room. These fans and dampers are utilized when the diesel generator is operating. Filtered air is provided from the exhaust of the Electrical Equipment Room and the Diesel Generator Room. When the diesel generator is not in operation, the area will be ventilated by the two centrifugal exhaust fans E-61 (1-SA), E-61 (1B-SA), and associated dampers as shown on Figure 9.4.5-2. Ventilation is also provided via the diesel generator room.

An electrical heating unit EUH-63 (1A-NNS) is provided for heating the area as shown on Figure 9.4.5-2.

9.4.5.2.5.5 HVAC Equipment Room Ventilation System

Air is drawn through this area by the two centrifugal exhaust fans via the adjacent silencer room as shown on Figure 9.4.5-2. During diesel operation, combustion air is withdrawn via the engine air intakes from this area through filters as described in Section 9.5.8 and shown on Figure 9.5.5-2. Electric heater units are provided for room heating.

9.4.5.2.6 Emergency Service Water Intake Structure Ventilation System

The Emergency Service Water Intake Structure Ventilation System is shown on Figure 9.4.5-2. Design Data for system principal components are presented in Table 9.4.5-7.

The ventilation system consists of Electric Equipment Room HVAC System and Emergency Power Pump Ventilation System.

1. Electric Equipment Room HVAC System - The Electric Equipment Room HVAC System consists of two air handling units, one for each of two electrical MCC Room. Each air handling unit consists of medium efficiency filters, a duct-mounted electrical heating coil, service water cooling coil (isolated) and a centrifugal fan. The system operates during emergency conditions and summer conditions. During winter conditions, the system can be manually started as required. An electrical unit heater for each room is also provided for supplemental heating in winter as needed.

   The fans for air handlers AH-86A & B function only to provide air flow to the non-safety ERFIS Mux Cabinets and for a non-safety heating function. Testing determined that even if the fans do not function, the maximum temperature in the ESW Electric Equipment Room would not exceed 107 °F. The ESW Electric Equipment Room maximum EQ temperature is 116 °F. Therefore, AH-86A &B do not provide any safety function.

   Air is drawn from outside through a missile protected louver and supplied to the MCC room. Exhaust air is relieved to the atmosphere through a missile protected louver.

All of the air from the MCC room is returned to the air handling unit for recirculation when the outside air temperature is less than 73°F. Motorized dampers are provided for this operation.

2. Pump Room Ventilation System - The Pump Room Ventilation System operates during emergency conditions and it can be started manually as required during normal conditions.

The Pump Room Ventilation System consists of two exhaust systems. Each system exhausts and ventilates a single pump room. The exhaust unit consists of a vaneaxial inline fan with a gravity discharge damper. Air is drawn from outside through missile protected louvers to the emergency pump room and discharged to atmosphere through a missile protected louver. Four electric unit heaters are provided for each pump room to maintain the room temperature at a nominal 51°F.

9.4.5.3 Safety Evaluation

9.4.5.3.1 Reactor auxiliary building ESF equipment cooling system

The ESF fan-coolers are required to operate during accident conditions in order to maintain an acceptable operational environment for the engineered safety features equipment located in the areas served. The ESF fan-coolers and associated ductwork are designed to meet Seismic Category I and Safety Class 3 requirements. In the event of loss of offsite power coincident with a Safety Injection Signal, the fan motors are powered by the same standby power source that serves the respective ESF equipment in that room.

During normal operation, the ESF fan-coolers are energized when the room temperature rises above its setpoint.

Loss of one ESF fan-cooler will result in the loss of cooling to only the respective area that fan-cooler served. Therefore, no single active failure can result in loss of cooling of more than one area. A single failure analysis is presented in Table 9.4.5-8.

The essential portions of the Reactor Auxiliary Building ESF Equipment Cooling System are protected from the effects of high and moderate energy line breaks (see Section 3.6).

Failures of non-Seismic Category I equipment or components will not result in damage to essential portions of the Reactor Auxiliary Building ESF Equipment Cooling System.

The Steam Tunnel Ventilation System is designed to meet Seismic Category I and Safety Class 3 requirements. The steam tunnel post LOCA cooling requirements can be satisfied by the operation of either fan. The idle fan remains on standby service. The ventilation system is not required to operate during plant shutdown.

In the event of loss of offsite power, the fan motors are powered by the standby emergency power sources.

The essential portions of the Steam Tunnel Ventilation System are protected from the effects of high and moderate energy line breaks (see Section 3.6).

Failures of non-Seismic Category I equipment or components will not result in damage to essential portions of the Steam Tunnel Ventilation System.

9.4.5.3.2 Reactor Auxiliary Building Switchgear Rooms Ventilation

The Reactor Auxiliary Building Switchgear Room Ventilation System is required to operate during both normal and accident conditions to maintain an acceptable operational environment for the safety related equipment located in each switchgear room envelope. Consequently, the system is designed to meet Safety Class 3 and Seismic Category I requirements. No single active failure will result in loss o ventilation to any switchgear room.

The cooling coils for each switchgear room ventilation system are piped independently; each cooling coil is piped separately on opposite sides of the air handling unit. Therefore, separation criteria for safety related components have been met.

In the event of loss of offsite power, all motors, controls, valve and damper operators will be switched to the emergency power sources. Refer to Table 9.4.5 9 for a single failure analysis of the Reactor Auxiliary Building Switchgear Room Ventilation System.

The essential portions of the Reactor Auxiliary Building Switchgear Room Ventilation System are protected from the effects of high and moderate energy line breaks (see Section 3.6).

Failures of non-Seismic Category I equipment or components will not result in damage to essential portions of the Reactor Auxiliary Building Switchgear Room Ventilation System.

9.4.5.3.3 Reactor Auxiliary Building Electrical Equipment Protection Room Ventilation System

The Reactor Auxiliary Building Electric Equipment Protection Rooms Ventilation System is required to operate during both normal and accident conditions to maintain an acceptable operational environment for the safety related equipment located in each electrical equipment and protection room. Consequently, the system is designed to meet Safety Class 3 and Seismic Category I requirements.

No single active failure will result in loss of ventilation capability to both electrical equipment and protection rooms. A single failure analysis is shown in Table 9.4.5-10.

In the event of loss of offsite power, all motors, controls, valves and damper operators will be switched to the emergency power sources. Non-electric controls and operators are designed to fail in the safe position.

The essential portions of the Reactor Auxiliary Building Electrical Equipment Protection Room Ventilation System are protected from the effects of high and moderate energy line breaks (see Section 3.6).

Failures of non-Seismic Category I equipment or components will not result in damage to essential portions of the Reactor Auxiliary Building Electrical Equipment Protection Room Ventilation System.

9.4.5.3.4 Fuel Oil Transfer Pump Room Ventilation System

The Fuel Oil Transfer Pump Room Ventilation System is designed to meet Safety Class 3 and Seismic Category I requirements. The system is capable of operation during normal and emergency conditions, but performs no safety related function required to support diesel generator operation.

Each exhaust system including ductwork is physically separated from the other system to assure the system is capable of meeting the single failure criteria. During normal operation, failure in one of the components of the Fuel Oil Transfer Pump Ventilation System does not affect the operability of the ventilation system.

The exhaust fans of the Fuel Oil Transfer Pump Room Ventilation System are powered by their respective redundant emergency power supply from the diesel generators.

During emergency conditions, a single failure in the ventilation system can affect only one of the two fuel oil transfer pump rooms. Therefore, one fuel oil transfer pump is available to mitigate the consequences of a design basis accident. The affected fuel oil transfer pump also remains fully operable even with its respective ventilation system not operational.

The electric unit heaters are not safety related and, consequently, are not required to operate during emergency conditions. Upon a loss of power, the heaters will shut down.

Missile protection barriers are provided for the outdoor air intakes and exhausts to absorb the possible impact of tornado missiles.

The essential portions of the Fuel Oil Transfer Pump Room Ventilation System are protected from the effects of high and moderate energy line breaks (see Section 3.6).

Failures of non-Seismic Category I equipment or components will not result in damage to essential portions of the Fuel Oil Transfer Pump Room Ventilation System.

9.4.5.3.5 Diesel generator building ventilation system

The Diesel Generator Building Ventilation System is designed to meet Safety Class 3 and Seismic Category I requirements. In the event of loss of offsite power, each system is powered from its respective emergency diesel generator.

Failure in one of the components of the Diesel Generator Building Ventilation System during normal operation does not affect the operability of the ventilation system. During emergency conditions, a single active failure in one of the components of the ventilation system can affect only one of the two diesel generators. Therefore, one diesel generator is available to mitigate the consequences of a design basis accident and to provide safety plant shutdown.

The electric unit heaters are not safety related; they are not required to operate during emergency conditions. Upon a loss of power, the heaters will shut down.

The essential portions of the Diesel Generator Building Ventilation System are protected from the effects of high and moderate energy line breaks (see Section 3.6).

Failures of non-Seismic Category I equipment or components will not result in damage to essential portions of the Diesel Generator Building Ventilation System.

9.4.5.3.6 Emergency Service Water Intake Structure Ventilation System

The Emergency Service Water Intake Structure Ventilation is designed to meet Safety Class 3 and Seismic Category I requirements. In the event of loss of offsite power, each subsystem is powered from its respective emergency diesel generator.

A single active failure in the ventilation system can affect only one of the two MCC rooms or pump rooms. Cooling water is isolated to the ESW Electrical Equipment Room cooling coils and the fans (AH-86A & B) are not required for safe shutdown. Therefore, one pump is available to mitigate the consequences of a design basis accident and to provide safe plant shutdown.

Air handlers AH-86A &B will be maintained as safety related fans to provide the air flow for ERFIS Mux Cabinets non-safety function and backup heating units. The air handler (AH-86A &B) fans are not required for any Technical Specification action statement (LCO).

Missile barriers are provided for the outside air intake and discharge to absorb the possible impact of tornado missiles.

The electric heaters are not safety related; they are not required to operate during emergency conditions. Upon loss of power, the heaters will shut down.

The essential portions of the Emergency Service Water Intake Structure Ventilation System are protected from the effects of high and moderate energy line breaks (see Section 3.6).

Failures to non-Seismic Category I equipment or components will not result in damage to essential portions of the Emergency Service Water Intake Structure Ventilation System.

9.4.5.4 Inspection and Testing Requirements

To ensure and demonstrate the capability of the Engineered-Safety-Feature Ventilation System, the system components and equipment are subjected to testing to verify proper wiring and control hookup, proper function of system components and control devices, and to establish system design air flow rates.

System air balance test and adjustment to design conditions are conducted in the course of pre-operational and startup tests as described in Section 14.2.12. Automatic controls are tested for actuation at proper setpoints. Alarm functions are checked for operability and limits during pre-operational testing.

Periodic tests, as required by Technical Specifications will be performed. Inservice inspection will be performed in accordance with Section 6.6 for Safety Class 3 components.

9.4.6 BOP INTERFACE

Since SHNPP does not reference a standard plant design, this section is not applicable.

9.4.7 CONTAINMENT VENTILATION SYSTEM

9.4.7.1 Design Bases

The Containment Building Ventilation System which consists of the Airborne Radioactivity Removal System and Containment Atmosphere Purge Exhaust System is designed to the following design bases:

a) Remove airborne particulate radioactivity and reduce the concentration of radioactive iodine in the containment atmosphere by recirculating the atmosphere through HEPA filters and charcoal adsorbers to permit personnel entry.

b) Maintain low concentration of radioactivity in the containment atmosphere by continuously purging the Containment with a low volume of outside air and allow the system to draw down the containment atmosphere to a slight negative pressure.

c) Reduce the concentration of radioactivity in the containment atmosphere to an acceptable level by purging the containment with a high volume of outside air to permit personnel access.

9.4.7.2 System Description

9.4.7.2.1 Airborne Radioactivity Removal System

The Airborne Radioactivity Removal System is shown on Figure 6.2.2-3. Design data for principal system components are presented in Table 9.4.7-1. The system consists of two recirculating airborne radioactivity removal units (one operating and one stand-by). Each unit includes a medium efficiency filter bank, a HEPA filter bank, a charcoal adsorber bank and a centrifugal fan.

The airborne radioactivity removal unit is operated on a continuous basis to limit the build up of airborne radioactivity which might leak from the Reactor Coolant System during normal operation. The concentration of particulate and gaseous activities present in the containment atmosphere is monitored by the Radiation Monitoring System. The airborne radioactivity removal units can be manually started from the Control Room.

The airflow and charcoal adsorber temperature is alarmed in the Control Room during system operation.

9.4.7.2.2 Containment Atmosphere Purge Exhaust System

The Containment Atmosphere Purge Exhaust System (CAPES) consists of two (2) subsystems: one low flow subsystem is used during power generation, the Normal Containment Purge System (NCP); and one high flow subsystem is used for high flow prior to Containment entry, the Containment Pre-Entry Purge System (CPP).

Both subsystems are common penetrations for purge and makeup in the Containment. The containment penetrations are 42 in. lines with two 42 in. isolation valves in series, one on each side of the containment wall. Valves with 8 in. taps are located between the 42 in. isolation valves and the containment wall both inside and outside the Containment.

The 42 in. lines are used by the Containment Pre-Entry Purge System (CPP) and Containment Pre-Entry Purge Make-up (CPPMU) System, while the 8-in. lines are used by the Normal Containment Purge System (NCP) and Normal Containment Purge Make-up (NCPMU) System. This arrangement allows the CPP and CCPMU isolation valves to remain closed during power operation. The common air intake for both makeup subsystems is missile protected and provided with a tornado damper.

The Containment Atmosphere Purge Exhaust System is shown on Figure 6.2.2-3.

1. Normal Containment Purge (NCP) System - The Normal Containment Purge (NCP) System is an in-line system used for low flow purge during normal power generation periods. Air is drawn from the discharge portion of the Airborne Radioactivity Removal System located in the Containment Building to the Reactor Auxiliary Building Normal Exhaust Filter System (Section 9.4.3). The Normal Containment Purge line is 8 in. in diameter and is isolated from the Containment Pre-entry Purge System by means of pneumatically operated butterfly valves and dampers. Purge air is discharged to the atmosphere through the vent stack via the RAB Normal Exhaust Systems. Make-up air is supplied by the Normal Containment Purge Make-up system (NCPMU). The NCPMU unit includes a medium efficiency filter bank, an electric heating coil and two centrifugal fans (one operating and one standby). Each fan is provided with an inlet isolation damper to prevent air recirculation through the idle fan. The design data for principal system components are presented in Tables 9.4.7-1 and 9.4.7-2.

   The Normal Containment Purge Exhaust is used to relieve the internal containment pressure by first permitting it to draw down the containment atmosphere to a slight negative pressure (to prevent outleakage). When the containment pressure is reduced to -0.400 in. w.g. as referenced to atmosphere, one of the two 100 percent capacity make-up fans will automatically start. The static pressure controller will regulate the respective supply fan inlet damper and exhaust air flow control damper to modulate and achieve the containment pressure setpoint of -0.375 in. w.g.

2. Containment Pre-Entry Purge System (CPP) - The CPP in conjunction with the NCP is used for high flow purge rates just prior to and during the refueling operation or other extended activity in the Containment Building. A portion of the exhaust air is drawn from the refueling cavity area and the remainder is drawn from the containment area.

   The CPP exhaust unit includes an isolation damper, a medium efficiency filter bank, a HEPA filter section, a charcoal adsorber section, an isolation damper and two centrifugal exhaust fans (one operating and one standby). Each fan is provided with an inlet pneumatic damper and a gravity type discharge damper to prevent air recirculation through the idle fan. The fans are furnished with variable inlet vanes for air volume control. A bypass duct with pneumatic isolation damper is provided for the CPP exhaust unit so that the system can also be operating during maintenance of filters or charcoal adsorber section. Air is discharged to atmosphere through a vent stack. The design data for principal components for the CPP exhaust unit are presented in Table 9.4.7-3.

   The CPP exhaust unit also serves as a standby or backup unit for the RAB Normal Exhaust System during plant power operation. If running, the CPP exhaust unit is automatically secured upon receipt of a Control Room Isolation Signal (CRIS). If the

necessary NNS power supplies are available, the CPP exhaust unit will also receive a signal to secure if a Containment Ventilation Isolation Signal (CVIS) or a Containment Pre-Entry Purge Radiation Monitor high radiation signal is present. Interconnecting ductwork with dampers is provided to facilitate this function.

Make-up air is drawn from outside and supplied to the Containment Building by the Containment Pre-Entry Make-Up System (CPPMU). The CPPMU system consists of a medium efficiency filter, an electric heating coil and two vane-axial fans (one operating and one standby). Each fan is provided with an inlet pneumatic isolation damper to prevent air recirculation through the idle fan. Design data for principal components of CPPMU system are presented in Table 9.4.7-4.

9.4.7.3 Safety Evaluation

The Airborne Radioactivity Removal System is not safety related, the system is not required to operate during accident conditions. Upon a loss of power, the system will be shut down.

The Containment Atmosphere Purge Exhaust System is not safety related and is not required to operate under accident conditions. Upon loss of power, the system will shut down. The containment isolation valves are air operated, fail closed. Piping which is located inside the Containment as well as piping outside Containment up to and including the isolation valves is Safety Class 2 Seismic Category I. In addition a small portion of the ductwork beyond the isolation valves was detailed on Figure 6.2.2-3. This portion of the ductwork and piping beyond the isolation valves has been voluntarily upgraded to Safety Class 3 design requirements, but for operational considerations, this ductwork and piping is classified as non-nuclear safety.

The performance and reliability of the purge system isolation valves are consistent with the operability assurance program outlined in MEB Branch Technical Position MED-2, "Pump and Valve Operability Assurance Program." The design basis for the valves and actuators include the buildup of containment pressure for the LOCA break spectrum, and the purge line and vent line flows as a function of time up to and during valve closure.

The containment isolation provisions for the purge system are in accordance with the guidelines detailed in Section 6.2.4. NCP and NCPMU system isolation valve closure times, including instrumentation delays, do not exceed five seconds. In addition, an inlet screen on the normal containment purge make-up line inside the containment is provided to ensure that isolation valve closure will not be prevented by debris.

The screen is approximately 2 pipe diameters away from the inner side of the inboard isolation valve. The screen as well as the piping between the isolation valve and screen is classified seismic Category I. Screens will be constructed of ASTM Grade A580 Type 304 stainless steel 11 gage wire (.1205 in. diameter) having a tensile strength of 90,000 psig with 3/4" to 1" square mesh. The screen is designed for a LOCA pressure differential of 45.0 psig.

Provision for a debris screen on the normal containment purge exhaust line is not pertinent since its isolation valve is located in a closed ductwork system as shown in Figure 6.2.2-3. The ductwork section from the inner side of the inboard isolation valve is classified as seismic Category I for a distance of approximately 5 pipe diameters. The seismic section of ductwork is installed vertically with (2) 45° elbows upstream of the isolation valve which would prevent any debris from becoming lodged in the event of a break in the non-seismic portion of ductwork.

The purge system is not relied upon for temperature and humidity control inside the Containment. The effect of purging the Containment with the NCP system at the time a LOCA occurs has been evaluated. The historical basis offsite dose consequences are well within the guidelines of 10 CFR 100.

9.4.7.4 Inspection and Testing Requirements

The Containment Building Ventilation System preoperational and startup tests are described in Section 14.2.12. Periodic tests as required by the Technical Specifications will be performed. Inservice inspection will be performed in accordance with Section 6.6, and the valve testing requirements of Section 3.9.6 will apply. Also, refer to Section 1.8 for applicable Regulatory Guide requirements.

9.4.7.5 Instrumentation

Independent instrument and control systems, provided to isolate the purge system lines, are activated by diverse parameters; i.e., CVIS actuation and containment radiation level.

9.4.8 CONTROL ROD DRIVE MECHANISM (CRDM) VENTILATION SYSTEM

The CRDM Ventilation System is a forced air cooling system provided for removal of heat from the CRDM magnetic coil windings. The system is designed as an integral portion of the shroud-head package to reduce the time spent preparing for fuel movement.

9.4.8.1 Design Bases

The CRDM Ventilation System is designed in accordance with the following requirements:

a) The system will maintain the temperature of the stationary and movable gripper and lift coils wiring insulation below 392°F during normal reactor operation.

b) The system shall have the capability of supplying a minimum of 40,000 cfm cooling air flow in the situation where the normal power supply is interrupted and when the reactor is maintained at hot standby.

9.4.8.2 System Description

The CRDM Ventilation System is a forced air cooling system which provides a reliable supply of cooling air to the CRDM magnetic coil housing during normal reactor operation. The system draws containment air into a plenum area above the CRDM assemblies and down over the faces of the coil housings. The air exits below the coil housing and across the upper surface of the reactor vessel head via return duct to centrifugal fans which exhaust to the containment atmosphere.

The system consists of four 50 percent capacity centrifugal fans mounted on the upper section of the shroud structure, at the 45, 135, 225, and 315° axes. Each of these fans is capable of exhausting 20,000 cfm of air at approximately 8-inches of water pressure at 200°F. Internal baffles provided between the cooling shroud and the outer row of mechanisms along with dummy CRDM cans, which occupy positions which do not contain mechanisms, create an exhaust plenum between the reactor vessel head and the lower mechanism coil housings.

Ducts located inside the shroud structure direct air from this plenum up to and through the fans located on the upper portion of the shroud structure. The CRDM Ventilation System parameters are identified in Table 9.4.8-1.

9.4.8.3 Safety Evaluation

During normal operation, two CRDM cooling fans will be in operation to supply 40,000 cfm air flow through the CRDM coil area. The two other CRDM cooling fans are standby units which can be started manually by the control room operator. Upon failure of one or both fans, lighted indication will show in the control room due to loss of air flow.

The CRDM Ventilation System is not a safety-related system; however, in the situation where the normal power supply is interrupted and the reactor is maintained at hot standby, the CRDM Ventilation System can be operated from the emergency power supply. The arrangement assures a minimum air flow to prevent damage to the CRDM components by limiting the maximum temperature in accordance with the rated life of the equipment.

It is highly unlikely that a complete loss of CRDM cooling could occur because of the system design and use of multiple fans. In the unlikely event of a complete loss of CRDM cooling air, assuming hot reactor operation, the area around the CRDMs would reach 392°F in 2 to 5 minutes. However, if the reactor is tripped, it would take approximately 30 minutes to reach 392°F with loss of all cooling. The CRDMs contain Class H insulation and loss in life can be estimated from NEMA curves of insulation life versus temperature. Continuous overheating will eventually result in shorting of the coils and tripping of the rods. This is not a safety-related problem since these coils do not perform a safeguards function.

9.4.8.4 Inspection and Testing Requirements

Prior to delivery onsite, the CRDM Ventilation System was shop assembled and checked for proper fitup, as well as functional and running operation. The CRDM cooling fans were operated to ensure that all design considerations were satisfied.

Once assembled to the reactor vessel head, the system was again inspected for proper fitup. Upon initial startup of the CRDM cooling fans, the cooling air flow was monitored and adjusted to the maximum operating capacity. All instrumentation indicating fan operation is checked and verified.

9.4.8.5 Instrumentation Requirements

Limit switches are provided on each CRDM cooling fan shutter. This provides indication of loss of the cooling fan, due to a low flow or motor overload condition and provides annunciation in the main control room or auxiliary control room when in use. Each fan control switch in the control room provides indication of the electrical status of each CRDM cooling fan motor.

9.4.9 COMPUTER/COMMUNICATION ROOM COMPLEX (CCRC)

The Computer/Communication Room Complex is located on two levels of the Reactor Auxiliary Building: The Computer and Communication Rooms are located on Elevation 305.0, the Battery and HVAC Equipment Rooms are located in a super-structure on the RAB roof, and the

air cooled refrigerant condensing units are located on the RAB roof. The entire complex is served by the following independent systems:

a) Computer Room Communication Rooms HVAC System

b) Battery and HVAC Equipment Room HVAC System

9.4.9.1 Design Bases

9.4.9.1.1 Computer and communication rooms HVAC systems (CCRS)

The CCRS is designed to:

a) Maintain the Computer Room and the Communication Room at a design temperature of 75 F dry bulb assuring personnel comfort as well as a suitable environment for continuous operation of equipment.

b) Reduce the consequences of a radiological accident. Although it is not designed to withstand natural phenomena such as earthquakes, tornados or tornado generated missiles with the exception that areas served at Elevation 305.0 (RAB) are protected from both tornados and tornado generated missiles.

c) Automatically isolate all air intakes following receipt of an isolation signal from the radiation monitors in the control room air intakes. (The same signal serves to isolate the control room.)

d) Remove smoke in the event of a fire.

e) Provide sufficient standby of active components to assure continuous reliable operation, with motors provided with two alternate, normal, automatically transferable power sources.

f) Permit testing, adjustment and inspection of the principal system components on a regular basis to assure system functional reliability.

g) Maintain a positive pressure in the Communication Room by use of pressure differential control instrumentation to limit inleakage of the surrounding environment.

9.4.9.1.2 Battery and HVAC equipment room HVAC system (BEQRS)

The BEQRS is designed to:

a) Provide once-through Battery Room ventilation which is capable of maintaining the hydrogen below the allowable limits (2% by volume). Maintain the Battery Room and HVAC Equipment Room temperature at a design temperature of 75°F dry bulb.

b) Remove smoke in the event of fire.

c) Provide sufficient standby of active components to assure continuous reliable operation, with motors provided with two alternate, normal, automatically transferable power sources.

9.4.9.2 System Description

9.4.9.2.1 Computer and Communication Room HVAC System

The CCRS serves the following spaces:

a) Computer Room

b) Communication Room

The Computer and Communication Room HVAC System (CCRS) Air Flow and Refrigerant Flow diagrams are shown on Figures 9.4.9-1 and 9.4.9-2, respectively. Design data for principal system components are presented in Table 9.4.9-1.

The CCRS is designed to maintain a design temperature of 75°F in the Computer and Communication Room under maximum load conditions during normal operation. Proper load and diversity factors were taken into consideration to determine cooling requirements. In the cooling mode the air is cooled by DX cooling coils (one operating and one standby) connected by refrigerant piping to the air cooled refrigerant condensing units (one operating and one standby). In the heating mode the air is heated by the electric heating coil to maintain design space temperatures.

The CCRS consists of the following: (All equipment is non-safety unless specifically noted)

a) The supply air system which includes, in the direction of air flow, a louvered outside air intake with two (2) motorized isolation valves, arranged in series, for normal operation, a louvered outside air intake with one (1) motorized isolation valve and one (1) electric preheat coil for smoke purge operation; one (1) medium efficiency filter, two (2) 100 percent redundant centrifugal fans arranged in parallel. Each fan is provided with a manual discharge damper and a motorized discharge damper. Two (2) 100 percent redundant electric heating coils are installed at fan discharge sides. The air supply and return ductwork is provided with dampers and valves for the air volume control and isolation. The air supply and return ducts penetrating the RAB roof are equipped with the Safety Class 3, Seismic Category I self-acting tornado dampers and are protected from tornado generated missiles.

   Each DX cooling coils is connected by refrigerant piping to an air cooled refrigerant condensing unit. The two (2) condensing units are mounted on the RAB roof, outside of the HVAC Equipment Room.

b) A normal exhaust consisting of two (2) motorized isolation valves arranged in series.

c) A SMOKE Purge Exhaust System with a purge fan, a motorized butterfly valve and a discharge louver.

d) An Air Filtration System consisting of: (in the direction of air flow) an emergency outside air intake louver, a flow element, two (2) motorized butterfly valves arranged in parallel, a motorized inlet damper, a medium efficiency filter, a HEPA pre-filter, a charcoal adsorber, a HEPA after-filter, two (2) 100 percent capacity fans arranged in parallel (one operating and one standby, each with a motorized inlet damper and gravity discharge damper) and a flow element.

9.4.9.2.1.1 CCRS - modes of operation

Normal Operation

During normal operation, the CCRS operates in a recirculating mode with the Air Filtration System de-energized. The outside makeup air bypasses the air filtration train and mixes with the return air before it is conditioned by the air handling unit. The CCRS maintains the spaces at a slight positive pressure with respect to other plant ventilation zones excluding the control room, so that the air from adjacent areas is prevented from entering the air conditioned space under all conditions. The pressurization of the space is maintained automatically by modulating the return air dampers from the Communication Room. The CCRS supply air temperature is thermostatically controlled with respect to the Communication Room cooling load. This is achieved by regulating the refrigerant compressor output to a DX cooling coil in combination with modulating of the electric reheat coil output, located on the discharge side of the air handling unit.

Post-Accident Operation

Assuming that all system components remain intact and in an operable condition, upon receipt of a high radiation isolation signal from the monitors in the outside air intakes of the CRACS, the following functions are performed automatically considering availability of off-site power:

a) All isolation valves at the normal outside air intakes will close. (One valve at the smoke purge makeup air intake is normally closed.)

b) The emergency air intake isolation valves are de-energized closed. This valve closure will ensure that the computer room cannot become pressurized which could adversely impact the required pressurization of the control room to all adjacent areas.

c) Deleted by Amendment No. 48

d) One isolation valve at the inlet of the smoke purge fan will receive a close signal. (This valve is normally closed.)

e) Both parallel fans at the air filtration unit will start, and their respective isolation dampers will open.

Following the completion of the above automatic functions, the operator will turn off one fan at the air filtration unit.

The Air Filtration System will filter the exhaust from the Computer and Communication Rooms. The Communication Room will be maintained under positive pressure by modulating damper CK-D12-1&2.

Smoke Purge Operation

In the event of a fire in the Computer or Communication Room, smoke detectors will sound an alarm and automatically shut off the supply system. The operator will remotely manually execute the smoke purging operation by restarting the supply system, starting the smoke purge fan and changing the operational status of valves and dampers and the air flow paths. Thus, the air flow pattern of the normal supply system supplemented by the purge intake becomes a once-through type. The electrical heating coil at the outside air intake is energized and controlled to maintain a minimum supply air temperature during winter purging.

9.4.9.2.2 Battery and HVAC equipment room HVAC (BEQRS)

The BEQRS serves the following spaces:

a) Battery Room

b) HVAC Equipment Room

The Battery and HVAC Equipment Room HVAC System is shown on Figures 9.4.9-1 and 9.4.9-2. Design data for principal system components are presented in Table 9.4.9-2.

The BEQRS is designed to maintain a design temperature of 75 F in the Battery Room and HVAC Equipment Room during normal operation. The Battery Room ventilation air flow rate is capable of maintaining the hydrogen gas concentration well below the allowable limits (2% by volume). The system flow rate is based on summer cooling requirements. In the cooling mode, the air is cooled by the DX cooling coils (one operating and one standby) connected by refrigerant piping to the air cooled refrigerant condensing units (one operating and one standby). In the heating mode, the air is heated by the electric heating coils to maintain design space temperature.

The BEQRS consists of the following:

a) The supply air system includes, in the direction of air flow, a louvered outside air intake with a motorized isolation damper, medium efficiency filters, one electric heating coil, two (2) DX cooling coils installed in series, two (2) 100 percent redundant centrifugal fans arranged in parallel and a flow element. Each fan is provided with a manual inlet damper and a motorized discharge damper.

b) Each DX cooling coil is connected by refrigerant piping to an air cooled refrigerant condensing. The two (2) condensing units are mounted on the RAB roof, outside of the HVAC Equipment Room.

c) Two (2) 100 percent redundant Power Room Ventilators for the Battery Room.

d) One (1) Power Room Ventilator for the HVAC Equipment Room. (Used for smoke purge only.)

9.4.9.2.2.1 BEQRS - modes of operation

Normal Operation

During normal operation, the BEQRS operates in a partially recirculated mode - the HVAC Equipment Room air is recirculated, and the Battery Room air is exhausted.

The BEQRS supply air temperature is thermostatically controlled, cooling and heating, with respect to the return air temperature. In the cooling mode, the output of the refrigerant compressor to a DX cooling coil is controlled. In the heating mode, the electric heating coil in the air handling unit is modulated. Also, during the heating mode, the Battery Room reheat coil is controlled by a room thermostat.

Smoke Purge Operation

During the smoke purge mode, the system reverts to 100 percent outside air. The air from the HVAC Equipment Room is exhausted by the Power Roof Ventilator.

9.4.9.3 Safety Evaluation

9.4.9.3.1 Computer and communication room HVAC system

The RAB Computer and Communication Room HVAC System is non-safety-related, except that the Seismic Category I duct penetrations to the RAB are provided with Safety Class 3, Seismic Category I tornado dampers to protect the Reactor Auxiliary Building.

The system is designed as non-nuclear safety since continuous operation of the system during design basis accident conditions is not required. However, motors are provided with alternate on-site automatically transferable power sources to assure continuous operation.

The system will respond to releases of radioactivity by using the Control Room isolation signal to isolate the system from the outdoor environment.

Smoke detectors will actuate an alarm, warning the operator to initiate the smoke purge operation in the event of a fire.

9.4.9.3.2 Battery and HVAC Equipment Room HVAC System

This system is not safety-related and will not be required to operate during a design basis accident. However, motors are provided with an alternate on site, automatically transferable power source.

9.4.9.4 Inspection and Testing Requirements

To ensure and demonstrate the capability of the Ventilation Systems, the system components and equipment are subjected to testing to assure proper wiring, control backup and proper function of system components and control devices, and to establish system design air flow rates.

The ventilation systems undergo preoperational and startup tests as described in Section 14.2.12. Also, refer to Section 1.8 for applicable Regulatory Guide requirements.

9.4.10 TURBINE BUILDING DECONTAMINATION FACILITY HVAC SYSTEM (TBDFS)

The Turbine Building Decontamination Facility HVAC System (TBDFS) is located in the Turbine Building at floor Elevation 261.00 ft. and the Air Cooled Refrigerant Condensing Unit is located on the north end of the Turbine Building at Elevation 286.00 ft. (Note: This area is not presently being used as a decontamination facility; however, the HVAC System description is valid.)

9.4.10.1 Design Bases

The TBDFS is designed to:

a) Provide heating, ventilating and cooling for personnel comfort during plant normal operation.

b) Provide potentially contaminated areas with once through ventilation.

c) Provide smoke purge during the event of a fire.

d) Provide redundant fans for Normal Exhaust System to assure continuous reliable operation.

e) Permit testing, adjustment and inspection of the principal system components on a regular basis to assure system reliability.

9.4.10.2 System Description

The TBDFS serve the following spaces:

a) Health Physics Room, Men and Women

b) Health Physics Office

c) Decontamination Rooms, Men and Women

d) Locker Rooms, Men and Women

e) Corridors and Vestibule

The Turbine Building Decontamination Facility HVAC System (TBDFS) Air Flow and Refrigerant Flow diagrams are shown on Figures 9.4.10-1. Design data for principal system components are presented in Table 9.4.10-1.

A design temperature of 75°F is used to provide personnel comfort under maximum load condition, during normal operation.

In the summer, the air is cooled by a DX cooling coil located in the Air Handling Unit. The coil is connected by refrigerant piping to an air cooled condensing unit located on the Turbine Building

roof. In winter, the air is heated by an electric heating coil installed in the same air handling unit, to maintain the design space temperature. The air is exhausted by normal exhaust fans. A smoke exhaust fan which is operated in conjunction with the normal exhaust fans and the air handling unit will assure smoke purge during the event of a fire. Air is exhausted from the TBDFS through a vent stack located on the roof of the Turbine Building.

The TBDFS consists of the following:

a) The Supply Air Handling System includes in the direction of air flow: outside air and return air operated dampers, an Air Handling Unit consisting of a mixing box, medium efficiency filters, an electric heating coil, a direct expansion refrigerant (DX) cooling coil and a centrifugal fan. A flow element is provided downstream of the Air Handling Unit.

b) An air cooled refrigerant condensing unit is provided at the North End of the Turbine Building and is connected to the DX cooling coil by means of refrigerant piping.

c) The Normal Exhaust system consists of two redundant fans and associated air inlet manual shutoff dampers and air discharge gravity dampers.

d) The smoke purge system consists of one smoke exhaust fan with a manual inlet shutoff damper and a discharge gravity damper.

9.4.10.2.1 Mode of Operation

9.4.10.2.1.1 Normal Mode

The air handling unit fan and one of the two exhaust fans are started manually. The outside air automatic damper is kept in the minimum position and the return air automatic damper is in the open position. The air cooled refrigerant condensing unit is energized when the air handling unit fan is operative and is controlled by a space thermostat set at 75 F. The electric heating coil is energized by interlock with the air handling unit fan motor and controlled by a return air thermostat.

9.4.10.2.1.2 Smoke Mode

Smoke detectors shall automatically shut off the air handling unit and sound an alarm at the Fire Detection Panel (FDP). Operator manually starts the Air Handling Unit and the smoke exhaust fan for smoke purge. The outside air damper automatically assumes a full open position and the return air automatic damper closes. The normal exhaust fan continues to run.

9.4.10.3 Safety Evaluation

The TBDFS is not safety related. The system will not be required to operate during accident condition. Upon a loss of power, the ventilation system will shut down.

9.5 OTHER AUXILIARY SYSTEMS

9.5.1 FIRE PROTECTION

The following information provides a general discussion of the Fire Protection Program and systems at the Shearon Harris Nuclear Plant (HNP).

Progress Energy has implemented the process for transitioning from the former deterministic fire protection program and licensing basis to compliance with a risk-informed, performance-based fire protection program as described in 10 CFR 50.48(c). Adoption of NFPA 805 Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants, 2001 Edition, in accordance with 10 CFR 50.48(c) serves as the HNP method of satisfying 10 CFR 50.48(a) and General Design Criterion 3. Prior to adoption of NFPA 805, General Design Criterion 3, "Fire Protection" of Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50, "Licensing of Production and Utilization Facilities," was followed in the design of safety and non-safety related structures, systems, and components, as required by 10 CFR 50.48(a). NFPA 805 does not supersede the requirements of GDC 3, 10 CFR 50.48(a), or 10 CFR 50.48(f). Those regulatory requirements continue to apply to licensees that adopt NFPA 805. However, under NFPA 805, the means by which GDC 3 or 10 CFR 50.48(a) requirements may be met is different than under 10 CFR 50.48(b). Specifically, whereas GDC 3 refers to SSCs important to safety, NFPA 805 identifies fire protection systems and features required to meet the Chapter 1 performance criteria through the methodology in Chapter 4 of NFPA 805. Also, under NFPA 805, the 10 CFR 50.48(a)(2)(iii) requirement to limit fire damage to SSCs important to safety so that the capability to safely shut down the plant is ensured is satisfied by meeting the performance criteria in Section 1.5.1 of NFPA 805.

The HNP fire protection program is based on the Nuclear Regulatory Commission (NRC) guidelines, Nuclear Electric Insurance Limited (NEIL) Property Loss Prevention Standards and related industry standards. With regard to NRC criteria, the HNP fire protection program follows the guidance of 10 CFR 50.48(c), which endorses, with exceptions, the National Fire Protection Association's 805, Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants-2001 Edition. HNP has further used the guidance of NEI 04-02, Revision 1, Guidance for Implementing a Risk-Informed, Performance-Based Fire Protection Program under 10 CFR 50.48(c), as endorsed by Regulatory Guide 1.205, Risk-Informed, Performance Fire Protection for Existing Light-Water Nuclear Power Plants.

9.5.1.1 Design Basis Summary

9.5.1.1.1 Application of NFPA 805

The design basis for Fire Protection at HNP is based on fire protection, nuclear safety objectives, and radiological release objectives put in effect under 10 CFR 50.48(c), which endorses, with exceptions, the National Fire Protection Association's 805, Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants-2001 Edition. HNP has further used the guidance of NEI 04-02, Revision 1, Guidance for Implementing a Risk-Informed, Performance-Based Fire Protection Program under 10 CFR 50.48(c), as endorsed by Regulatory Guide 1.205, Risk-Informed, Performance Fire Protection for Existing Light-Water Nuclear Power Plants. To this end, fire protection features are capable of providing

reasonable assurance that, in the event of a fire, the plant is not placed in an unrecoverable condition. This is demonstrated through meeting the following performance criteria:

a) Reactivity Control - Reactivity Control is capable of inserting negative reactivity to achieve and maintain subcritical conditions. Negative reactivity inserting will occur rapidly enough such that fuel design limits are not exceeded.

b) Inventory and Pressure Control - With fuel in the reactor vessel, head on and tensioned, inventory and pressure control is capable of controlling coolant level such that subcooling is maintained such that fuel clad damage as a result of a fire is prevented.

c) Decay Heat Removal - Decay heat removal is capable of removing sufficient heat from the reactor core or spent fuel such that fuel is maintained in a safe and stable condition.

d) Vital Auxiliaries - Vital auxiliaries are capable of providing the necessary auxiliary support equipment and systems to assure that the systems required under (a), (b), (c), and (e) are capable of performing their required nuclear safety function.

e) Process Monitoring - Process monitoring is capable of providing the necessary indication to assure the criteria addressed in (a) through (d) has been achieved and are maintained.

9.5.1.1.2 Defense-in-Depth

The HNP Fire Protection Program is focused on protecting the safety of the public, the environment, and plant personnel from a plant fire and its potential effect on safe reactor operations is paramount. The fire protection program is based on the concept of defense-in-depth. Defense-in-depth shall be achieved when an adequate balance of each of the following elements is provided:

a) Preventing fires from starting,

b) Rapidly detecting fires and controlling and extinguishing promptly those fires that do occur, thereby limiting fire damage.

c) Providing an adequate level of fire protection for structures systems, and components important to safety, so that a fire that is not promptly extinguished will not prevent essential plant safety functions from being performed of fire safety.

9.5.1.1.3 Performance Objectives

10 CFR 50.48(c) through NFPA 805 provides performance objectives for the HNP as follows:

Nuclear Safety Objectives for the plant, in the event of a fire during any potential mode and plant configuration, are as follows:

a) Reactivity Control shall ensure the capability of rapidly achieving and maintaining subcritical conditions.

1) Fuel Cooling shall ensure the capability of achieving and maintaining decay heat removal and inventory control functions.

2) Fission Product Boundary shall ensure the capability of preventing fuel clad damage so that the primary containment boundary is not challenged.

b) Radioactive Release Objectives shall ensure either of the following objectives shall be met during all operational modes and plant configurations.

   1) Containment integrity is capable of being maintained.

   2) The source term is capable of being limited.

9.5.1.1.4 Codes of Record

The codes, standards and guidelines used for the design and installation of plant fire protection systems are as follows: (for specific applications and interpretations of codes refer to design documents such as specifications and drawings)

a) American National Standards Institute (ANSI)

   B 31.1 1973 - Power Piping

   N45.2.9 1974 - Quality Assurance Records, protection from fire hazards

b) American Society for Testing Materials (ASTM)

   D-92-1978 Test for Flash and Fire Points by Cleveland open cup

   E-84-1980 Test for Surface Burning Characteristics of Building Materials

   E-119-1980 Standard Test Method for Fire Test of Building Construction and Materials

   E-136-1979 Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C

c) Factory Mutual Research (FM) Fire Protection Equipment Approval Guide

d) Institute of Electrical and Electronic Engineers (IEEE) Std. 383-1974 Standard for Type Test of Class 1E Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations, Std. 384-1974 Criteria for Separation of Class 1E Equipment and Criteria, Std. 634-1978 Standard Cable Penetration Fire Stop Qualification Test

e) National Fire Protection Association (NFPA)

   Std. No. 10-1978 - Standard for Portable Fire Extinguishers

   Std. No. 13-1978 - Installation of Sprinkler System

   Std. No. 13-2010 - Standard for Installation of Sprinkler Systems

Std. No. 14-1976 - Standpipe and Hose Systems

Std. No. 15-1977 - Water Spray Fixed Systems

Std. No. 15-2007 - Standard for Water Spray Fixed Systems for Fire Protection

Std. No. 20-1972 - Standards for Centrifugal Fire Pumps

Std. No. 24-1977 - Outside Protection

Std. No. 25-2011 - Standard for the Inspection, Testing and Maintenance of Water Based Fire Protection Systems

Std. No. 30-1977 - Flammable and Combustible Liquids Code

Std. No. 51B-1971 - Cutting and Welding Process

Std. No. 72-2007 - National Fire Alarm Code

Std. No. 72-2010 - National Fire Alarm and Signaling Code

Std. No. 72A-1975 - Local Protective Signaling Systems

Std. No. 72D-1975 - Proprietary Protective Signaling Systems

Std. No. 72E-1978 - Automatic Fire Detectors

Std. No. 80-1979 - Standard for Fire Doors and Fire Windows

Std. No. 90A-1981 - Air Conditioning and Ventilation Systems

Std. No. 101-1976 - Life Safety Code

Std. No. 251-1979 - Fire Tests, Building Construction and Materials

Std. No. 252-1976 - Fire Tests of Door Assemblies

Std. No. 600-2000 - Standard on Industrial Fire Brigades

Std. No. 701-1999 - Standard Methods of Fire Tests for Flame Propagation of Textiles and Films

Std. No. 805-2001 - Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants

Std. No. 37 - Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines

9.5.1.2 Systems Description

9.5.1.2.1 Applicable System

Applicable active fire protection systems are those fire suppression and detection systems installed where required to meet the performance or deterministic requirements of NFPA 805, Chapter 4, and are further described in the Progress Energy Shearon Harris Nuclear Power Plant, NFPA 805, Transition to 10 CFR 50.48(c) - NFPA 805, Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants, 2001 Edition, Transition Report, Attachment A - NEI 04-02 Table B-1 - Transition of Fundamental FP Program and Design Elements (NFPA 805 Chapter 3). Credited/required active fire suppression sprinkler systems are identified in the fire area FSAs and the NFPA 805 Code Compliance Calculation.

Likewise, passive fire protection system components are those systems and features installed where required to meet the performance or deterministic requirements of NFPA 805, Chapter 4, and are further described in the fire area FSAs and the NFPA 805 Code Compliance Calculation.

NFPA 805, Chapter 4 established the methodology to determine the fire protection systems and features required to achieve the performance criteria outlined in NFPA 805, Section 1.5. The methodology shall be permitted to be either deterministic or performance-based. Deterministic requirements shall be "deemed to satisfy" the performance criteria and require no further engineering analysis. Once a determination has been made that a fire protection system or feature is required to achieve the performance criteria of Section 1.5, its design and qualification shall meet the applicable requirement of Chapter 3.

9.5.1.2.2 Definition of "Power Block" Structures

For the purposes of establishing the structures included in the HNP fire protection program in accordance with 10 CFR 50.48(c) and NFPA 805, the following plant structures are considered to be part of the "power block". The following table provides clarification as described in FAQ 06-0019, Define Power Block (ML0850510224) to NEI 04-02.

Power block equipment includes all Structures, Systems, and Components (SSCs) required for the safe and reliable operation of the station. It includes all safety-related and balance-of-plant systems and components required for the operation of the station, including radioactive waste processing and storage and switchyard equipment maintained by the station. SSCs required to maintain federal or state regulatory compliance are included in this grouping. This equipment does not include buildings or structures that support staff, such as offices or storage structures, or the HVAC and support systems focused only on habitability of those structures.

"Power Block" buildings are listed in Table 9.5.1-1.

9.5.1.3 Safety Evaluation (Fire Hazard Analyses)

As part of the NFPA 805 Fire Protection Program, a Fire Safety Analysis (FSA) calculation document is provided for each plant fire area. The purpose of the FSA is to demonstrate the achievement of the nuclear safety and radioactive release performance criteria of NFPA 805 as required by 10 CFR 50.48(c), and as such are incorporated by reference to this section. The FSA is a key part of compliance with Section 2.7.1.2, "Fire Protection Program Design Basis

Document," of NFPA 805. This analysis also documents results of risk-informed, performance-based evaluations and serves as Progress Energy's design basis document (DBD) as described in NFPA 805, Section 2.7.1.2. FSAs provide evaluation associated with non-compliance from the pre-NFPA 805 licensing basis that have been analyzed and approved during NFPA 805 transition (transition change evaluations), along with future changes to the post-transition fire protection program that have been analyzed and approved per the requirements of the plant fire protection license condition (post-transition change evaluations).

The following information is documented in each FSA:

1. Review and documentation of existing classical fire protection strategy and features in the area. The information is typically what would have been in a plant's Fire Hazards Analysis prior to transition to NFPA 805. This may include suppression system assumptions and inadvertent actuation or mal-operation evaluations.

2. Identify significant fire hazards in the fire area. This is based on NFPA 805 approach to analyze the plant from an ignition source and fuel package perspective.

3. Summarize Nuclear Safety Capability Assessment (NSCA) compliance strategies. This is the result of the NEI 04-02 B-3 Table review of the Safe Shutdown Analysis.

4. Summarize Non-Power Operations Modes compliance strategies.

5. Summarize Radioactive Release compliance strategies. The transition review process required per NEI 04-02 is used to develop these results.

6. Provide Fire Probabilistic Risk Assessment (PRA) summary of results. This is based on the results from the plant Fire PRA.

7. Perform risk informed, performance based evaluations if needed for the performance based approach.

8. Summarize Defense-in-Depth strategy for each fire area.

9. Determine key analysis assumptions that are to be included in the NFPA 805 monitoring program.

10. Provide conclusions relative to NFPA 805 compliance.

Individual change evaluations, as needed, are documented in the Fire Safety Analysis (FSA) performed for each fire area. The format for the FSA is organized to follow the requirements for preparation and control of design analyses and calculations.

9.5.1.4 Inspection and Testing

9.5.1.4.1 Surveillance Requirements

Guidance for the operability, action, and surveillance requirements for fire protection systems requires meeting the performance or deterministic requirements of NFPA 805, Chapter 4, are provided in the Plant Operating Manual procedures(s) and supersede the original plant technical

specifications. Required systems are identified by fire area and required application in the Fire Safety Analysis (FSA) for each fire area.

Applicable systems are further described in HNP-M/BMRK-0011, Code Compliance Evaluation NFPA 805, Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants. Required system(s) requirements for operability, action, and surveillance are contained in the plant Fire Protection Program Manual.

9.5.1.4.2 Monitoring

A monitoring program is established to assess the performance of the fire protection program in meeting the performance criteria established in the standard. The monitoring program will be established to ensure that the availability and reliability of the fire protection systems and features are maintained and to assess the performance of the fire protection program in meeting the performance criteria. Monitoring will ensure that the assumptions in the engineering analysis remain valid and acceptable levels of availability, reliability and performance are maintained. The most important systems and features as determined by the NFPA 805 expert panel will have specific availability, reliability, and/or performance goals established. Assumptions that are not subject to change do not need to be monitored (e.g., ceiling height input maintained by configuration control process). Deterministic monitoring may carry forward as part of current surveillance processes. The level of monitoring of assumptions and performance are commensurate with associated risk significance.

9.5.1.5 Personnel Qualification & Training

9.5.1.5.1 Program Management

A fire protection program has been established as described in the HNP Fire Protection Program Manual (FPP-001). This manual along with other POM documents, provide the management policy and program direction and defines the responsibilities of those individuals responsible for the program implementation. This program manual established the criteria for an integrated combination of components, procedures, and personnel to implement all fire protection program activities. The program manual defines management authority and responsibilities and establishes the general policy for the site fire protection program. The manual designates the senior management position with immediate authority and responsibility for the fire protection program, along with designation of the position responsible for the daily administration and coordination of the fire protection program and its implementation. Qualifications for individuals responsible for administration of a fire protection program are discussed in Section 3.2 and Appendix A of NFPA 805 (ref., HNP-M/BMRK-0011, Code Compliance Evaluation NFPA 805, Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants). This includes recommendations that individuals responsible for day-to-day administration of the fire protection programs be experienced in nuclear power plant fire protection, preferably with a qualified fire protection engineer meeting Society of Fire Protection Engineers (SFPE) member grade qualifications. The manual defines the fire protection interfaces with other organizations and assign responsibilities for the coordination of activities. In addition, the manual identifies the various plant positions having the authority for implementing the various areas of the fire protection program. The program manual also identifies the appropriate Authority Having Jurisdiction (AHJ) for various site areas and portions of the fire protection program. Procedures have been established for implementation of

the various facets of the fire protection program in accordance with applicable regulatory and industry requirements and guidance.

9.5.1.5.2 Fire Brigade

On-site firefighting capability as described in NFPA 805 is ensured by the HNP Fire Brigade. Implementation and administrative controls for the NFPA 805 Fire Brigade Program (i.e. training, qualifications, drills) for Progress Energy at the HNP are contained in procedure FIR-NGGC-0007, NFPA 805 Fire Brigade Program, and detailed in HNP-M/BMRK-0011, Code Compliance Evaluation NFPA 805, Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants and HNP-M/BMRK-0012, Code Compliance Evaluation NFPA 600, Standard on Industrial Fire Brigades.

Pre-Fire Plans are available for use by the fire brigade and other plant staff responders. Radiation release to any unrestricted area due to the direct effects of fire suppression activities (but not involving fuel damage) will be as low as reasonably achievable and shall not exceed applicable 10 CFR 50, Part 20, limits. HNP meets the Radioactive Release Performance Criteria of NFPA 805, the detailed review of which is further described in the HNP-M/BMRK-0011, Code Compliance Evaluation NFPA 805, Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants.

REFERENCES: SECTION 9.5.1

9.5.1-1 HNP-E/ELEC-0001, SAFE SHUTDOWN ANALYSIS IN CASE OF FIRE

9.5.1-2 NFPA 805 TRANSITION, NON-POWER OPERATIONAL MODES REVIEW

9.5.1-3 HNP-M/MECH-1105, NFPA 805 Transition - Fire Area 1-A-BAL-C Fire Safety Analysis

9.5.1-4 HNP-M/MECH-1106, NFPA 805 Transition - Fire Area 12-A-BAL Fire Safety Analysis

9.5.1-5 HNP-M/MECH-1107, NFPA 805 Transition - Fire Area 1-A-BAL-E Fire Safety Evaluation

9.5.1-6 HNP-M/MECH-1108, NFPA 805 Transition - Fire Area 1-A-BAL-F Fire Safety Analysis

9.5.1-7 HNP-M/MECH-1109, NFPA 805 Transition - Fire Area 1-A-BAL-J Fire Safety Analysis

9.5.1-8 HNP-M/MECH-1110, NFPA 805 Transition - Fire Area 1-A-BATA Fire Safety Analysis

9.5.1-9 HNP-M/MECH-1111, NFPA 805 Transition - Fire Area 1-A-BATB Fire Safety Analysis

9.5.1-10 HNP-M/MECH-1112, NFPA 805 Transition - Fire Area 1-A-EPA Fire Safety Analysis

9.5.1-11 HNP-M/MECH-1113, NFPA 805 Transition - Fire Area 1-A-EPB Fire Safety Analysis

9.5.1-12 HNP-M/MECH-1114, NFPA 805 Transition - Fire Area 5-W-BAL Fire Safety Analysis

9.5.1-13 HNP-M/MECH-1115, NFPA 805 Transition - Fire Area 1-G Fire Safety Analysis

9.5.1-14 HNP-M/MECH-1116, NFPA 805 Transition - Fire Area 1-A-BAL-A Fire Safety Analysis

9.5.1-15 HNP-M/MECH-1117, NFPA 805 Transition - Fire Area 1-A-BAL-B Fire Safety Analysis

9.5.1-16 HNP-M/MECH-1118, NFPA 805 Transition - Fire Area 1-A-BAL-D Fire Safety Analysis

9.5.1-17 HNP-M/MECH-1119, NFPA 805 Transition - Fire Area 1-A-CSRA Fire Safety Analysis

9.5.1-18 HNP-M/MECH-1120, NFPA 805 Transition - Fire Area 1-A-CSRB Fire Safety Analysis

9.5.1-19 HNP-M/MECH-1121, NFPA 805 Transition - Fire Area 1-C Fire Safety Analysis

9.5.1-20 HNP-M/MECH-1122, NFPA 805 Transition - Fire Area 1-A-SWGRA Fire Safety Analysis

9.5.1-21 HNP-M/MECH-1123, NFPA 805 Transition - Fire Area 1-A-SWGRB Fire Safety Analysis

9.5.1-22 HNP-M/MECH-1124, NFPA 805 Transition - Fire Area 1-A-ACP Fire Safety Evaluation

9.5.1-23 HNP-M/MECH-1125, NFPA 805 Transition - Fire Area 12-A-HV&IR Fire Safety Analysis

9.5.1-24 HNP-M/MECH-1126, NFPA 805 Transition - Fire Area 12-A-CRC1 Fire Safety Analysis

9.5.1-25 HNP-M/MECH-1127, NFPA 805 Transition - Fire Area 12-A-CR Fire Safety Analysis

9.5.1-26 HNP-M/MECH-1173, NFPA 805 Transition - Fire Area 12-I-ESWPA Fire Safety Analysis

9.5.1-27 HNP-M/MECH-1174, NFPA 805 Transition - Fire Area 12-I-ESWPB Fire Safety Analysis

9.5.1-28 HNP-M/MECH-1175, NFPA 805 Transition - Fire Area 12-O-TA Fire Safety Analysis

9.5.1-29 HNP-M/MECH-1176, NFPA 805 Transition - Fire Area 12-O-TB Fire Safety Analysis

9.5.1-30 HNP-M/MECH-1177, NFPA 805 Transition - Fire Area 1-A-BAL-G Fire Safety Analysis

9.5.1-31 HNP-M/MECH-1178, NFPA 805 Transition - Fire Area 1-A-BAL-H Fire Safety Analysis

9.5.1-32 HNP-M/MECH-1179, NFPA 805 Transition - Fire Area 1-A-BAL-K Fire Safety Analysis

9.5.1-33 HNP-M/MECH-1180, NFPA 805 Transition - Fire Area 1-D-DGA Fire Safety Analysis

9.5.1-34 HNP-M/MECH-1181, NFPA 805 Transition - Fire Area 1-D-DGB Fire Safety Analysis

9.5.1-35 HNP-M/MECH-1182, NFPA 805 Transition - Fire Area 1-D-DTA Fire Safety Analysis

9.5.1-36 HNP-M/MECH-1183, NFPA 805 Transition - Fire Area 1-D-DTB Fire Safety Analysis

9.5.1-37 HNP-M/MECH-1184, NFPA 805 Transition - Fire Area 1-O-PA Fire Safety Analysis

9.5.1-38 HNP-M/MECH-1185, NFPA 805 Transition - Fire Area 1-O-PB Fire Safety Analysis

9.5.1-39 HNP-M/MECH-1186, NFPA 805 Transition - Fire Area 5-F-BAL Fire Safety Analysis

9.5.1-40 HNP-M/MECH-1187, NFPA 805 Transition - Fire Area 5-F-CHF Fire Safety Analysis

9.5.1-41 HNP-M/MECH-1188, NFPA 805 Transition - Fire Area 5-F-FPP Fire Safety Analysis

9.5.1-42 HNP-M/MECH-1189, NFPA 805 Transition - Fire Area 5-O-BAL Fire Safety Analysis

9.5.1-43 HNP-M/MECH-1190, NFPA 805 Transition - Fire Area 5-S-BAL Fire Safety Analysis

9.5.1-44 HNP-M/MECH-1191, NFPA 805 Transition - Fire Area FPYARD Fire Safety Analysis

9.5.1-45 Fire Protection Fire Hazards Analysis Drawings 2166-S-2100 through 2166-S-2135 (these replace FSAR Figures 9.5A-1 through 9.5A-41)

9.5.2 COMMUNICATION SYSTEMS

9.5.2.1 Design Bases

A comprehensive communications system is provided to assure reliable intraplant communication, offsite commercial telephone service, and offsite emergency communication capabilities.

9.5.2.2 Communication System Summary Description

The communication facilities are as follows:

a) Intraplant voice communication is provided by a Private Automatic Branch Exchange (PABX) telephone system which also interconnects with the Central Office of the Southern Bell Telephone System.

b) Intraplant voice paging is provided by a system of centralized audio power amplifiers and loud speakers located throughout the site.

c) Site alarm signals are carried by the paging system.

d) Containment Evacuation Alarm is provided, independent of Site Alarm Signals.

e) Sound powered headset intercom system provides communication for operational, maintenance, and emergency purposes.

f) A radio communications system is provided for communications by security, operations, and maintenance personnel using portable radios, base station remote control consoles, and repeaters.

g) Plant working stations located throughout the plant site are provided with communication facilities so that personnel can communicate with other working stations, the Control Room and the Auxiliary Control Room. The Control Room and Auxiliary Control Room are provided with PABX dial telephone, PA paging, radio, and sound-powered headset communication facilities.

h) Telephone and paging systems provide telecommunication support to the plant security communication system.

i) 120V AC power for the communication systems is supplied from a non-Class IE uninterruptible power supply (UPS) system through power distribution panels. During normal plant operation, power to the UPS system is supplied by 480V non-safety related MCC's. Upon loss of normal AC power the UPS system receives its power from the non-safety related 125V dc system.

j) Two-way voice communication, vital to safe shutdown and emergency response in the event of a fire is provided by the Operations, Maintenance, and security radio system in accordance with Appendix A of BTP 9.5-1. Additional portable radio channels and associated distributed antenna system have been provided throughout the RAB for Safe Shutdown manual action feasibility purposes. These Radio Repeaters are located in the K Building for system separation purposes.

k) Emergency Communications Systems are provided to serve as the back-up communications link between the site and other emergency facilities and environmental monitoring teams in the event of an emergency condition.

   The emergency communications systems will consist of emergency radios for environmental monitoring teams, emergency telephone, and the company telephone system.

l) The Emergency Telephone System operates through an emergency PBX located in the Shearon Harris Energy & Environmental Center (SHEEC). This PBX system is independent of the site PABX. In addition to microwave and normal telephone lines, an underground fiber optics cable system links the site with the SHEEC. The PBX in the SHEEC is powered from the SHEEC distribution system which is backed up by a battery system and a diesel generator.

m) The Emergency Radio System equipment is located in the Communications Room of the TSC. This equipment is similar in design and function to equipment provided for the Operations, Maintenance and Security Radio System. This system consists of a UHF emergency channel and a two-channel State Emergency VHF base station. The UHF equipment will use "digital voice protection" and a clear voice mode so that both private and non-private communications can be made. Power is supplied from the TSC distribution system. There is one UHF remote unit located in the TSC and one remote in the main control room. The VHF State Emergency remote unit is located in the TSC.

n) The CP&L Emergency Telephone System consists of microwave links between plant sites and other strategic points in the CP&L system.

o) A siren system has been installed to warn the general public within a ten-mile radius of the plant in the event of a radiological emergency. The siren system is described in the Emergency Plan.

The detailed description of these facilities is given in Subsection 9.5.2.3 and their block diagrams in Figures 9.5.2-1 through 9.5.2 6.

9.5.2.3 Detailed System Description

9.5.2.3.1 PABX telephone system

a) A site PABX telephone switch is owned and maintained by Carolina Power & Light Company. This PABX is connected to all site phones with the exception of the automatic ring-down phones, emergency phone lines from the SHEEC switch and unswitched business lines that connect directly to the central office switch (public system). The SHEEC PBX provides lines to the Main Control Room (MCR), Auxiliary Control Panel (ACP), Technical Support Center (TSC) and Operational Support Center (OSC). The unswitched business lines are available in the MCR, ACP, and the TSC. The site PABX is normally powered by the administration building distribution. The security building distribution is the emergency supply that has a diesel generator backup. The PABX is also backed up by a battery system. Some telephones have direct access to the Bell Systems. Other telephones are restricted to intraplant telephone calls. The PABX is modular and utilizes plug-in type components.

   The status of the system can be checked through the telephone operator's console. Any malfunction can be easily detected and usually corrected by replacing the affected module. If a line is severed or shorted, it will be automatically isolated by the switching equipment until it is repaired and the rest of the system will continue to function normally. In case of power failure, the switch will send an alarm signal to the Control Room.

   Desk, wall and weatherproof-type telephone instruments are installed as required and connected to the site PABX with shielded cable.

   The site PABX is located in the Administration Building. The PABX is equipped with an automatic fire detection and protection system. The PABX and supporting equipment is normally fed from service panels in the Administration Building. Upon loss of this power,

an automatic transfer switch will connect to a feed from security MCC which is backed up by the Auxiliary diesel generator in the Security Building.

9.5.2.3.2 Site paging system

1. The site paging system consists of three separate equipment racks capable of functioning independently. Each rack has preamplifiers, power amplifiers, an override module, site alarm signal module, power supply module, test panel, supervisory detection module and annunciator panel.

   The output of the power amplifiers feed independent 70 volt audio/signal transmission lines to which loudspeakers of various types are parallel connected, via line matching transformers.

   To improve operational efficiency the site paging system is divided into four zones plus an all zone mode. The zones are as follows:

Zone	Area Covered
A	Reactor, Reactor Auxiliary, Turbine and Diesel Generator Buildings
C	Fuel Handling and Waste Processing Building
D	Perimeter/Outlying Buildings
E	Administration Building/K Building/ Fire House

   Zones A and C each have a dedicated paging equipment rack. Zones D and E have a common equipment rack.

   The preamplifiers, power amplifiers, and active tone generators (described below) are monitored by a supervisory signal. Failure of any of these components is detected and annunciated locally at the rack and in the Control Room.

   Each paging equipment rack is provided with a spare preamplifier and power amplifier (to replace any of the active units) which can be normally connected to the subsystem with plug-in devices, and a standby tone generator (described in Paragraph b below) that will automatically be connected in each equipment rack in case of primary equipment failure.

   If a transmission line is severed, loudspeakers connected downstream of the break will be silenced. If a transmission line is shorted the channel is silenced.

   Voice paging signals are initiated from plant PABX telephones through the PABX telephone switching unit and interface equipment, or by "Communication Stations" located in the Control, Auxiliary and Waste Processing Control Rooms. The paging zones are accessed from the selected telephones by dialing the appropriate code number. The "Communication Stations" provide input to the paging system through the PABX telephone system and have priority over the PABX telephone initiated signal. Selector keys are provided at each of these "Communication Stations" to select zone priority access or all zone priority access control.

2. Each paging equipment rack has a site alarm signal module provided with two solid state tone generators. The tone generators are arranged such that one generator is active and the other is standby. If the active generator fails, the standby generator will be automatically

connected and an annunciation signal sent to the Control Room. Alarms are remotely controlled by control switch stations on the Control Room and Auxiliary Control Room. The tone generator signals are fed to the paging amplifiers and broadcast through the loudspeaker system covering the entire site.

Site alarm signals are in accordance with 10 CFR 50, Appendix E. Fire alarm signals meet appropriate NFPA Standards.

Paging System equipment added to outlying areas outside of the Protected Area (Warehouse 6 and 9, the Generator Rewind Building, and the Major Projects Office Complex (MPOC)) do not meet all of the requirements described above. These speakers are not part of any zone. These systems have their own amplifiers and receive the paging signal from Zone D speaker circuits. The system is not redundant and a failure is not annunciated in the control room.

9.5.2.3.3 Containment evacuation alarm

A containment evacuation alarm is provided for the containment building to notify plant personnel in the building of a radiation hazard. This alarm is independent from the plant high level paging and alarm system. The alarm is initiated via a station provided in the Main Control Room.

9.5.2.3.4 Sound powered headset intercom system

The sound-powered headset communication system consists of remote jack stations, master panels, sound powered headsets and wiring. It provides communication between the Control Room, Auxiliary Control Room, Technical Support Center, Operational Support Center, PASS Panel, and technicians adjusting remote instrumentation and performing other routine maintenance. The system is available for use by all plant personnel. It is segmented so that the Waste Processing Building, Fuel Handling Building, and the remainder of the plant each have independent five channel systems. The refueling operation has one dedicated channel in this system. The system is accessed via jack stations located at or near control panels, relay cabinets, instrument racks, switchgear, MCC's, motors, pumps and important equipment.

Wiring terminates in the Control Rooms where plug in patches can be made in the master panel to allow temporary channel interconnections should this be necessary.

A five jack assembly is provided at each remote station, into which the portable headset equipment can be plugged. This arrangement allows for hands free operation and requires no amplifiers. This system also serves as backup to the normal communications system (PABX).

For locations essential to safe shutdown evolutions and emergency operating procedure communications for operation of main steam PORV's, Channels 1, 2, 21, and 22 of the sound-powered phones are maintained to higher standards than the other channels to ensure increased reliability and availability.

Interconnection between the Auxiliary Control Panel, Transfer Panels, and Auxiliary Transfer Panels is required to remain free from fire damage in case of fire in the Main Control Room and/or adjacent areas (Fire Areas 12-A-CR, 12-A-CRC1, 12-A-HV&IR) to support Alternate Safe Shutdown. A two channel, dedicated Sound Powered Headset Intercom System circuit is

provided to support Alternate Safe Shutdown with Jacks located near the Auxiliary Control Panel, Transfer Panels A and B, and Auxiliary Transfer Panels A and B. This circuit is independent from all other Sound Powered Headset Intercom circuits and is completely contained within the RAB 286' elevation to remain isolated from the Main Control Room and/or adjacent areas (Fire Areas 12-A-CR, 12-A-CRC1, 12-A-HV&IR).

Each channel/circuit of the five and two channel systems consists of a two-conductor shielded line interconnecting the remote stations. If a zone cable is severed producing an open circuit, the jack stations connected downstream will be lost. If the wires are shorted, sound powered communication in the respective independent five or two channel system will be partially or totally lost.

The sound powered system is a simple system that does not require a power supply. Component failure is minimal.

9.5.2.3.5 Radio system

An interior antenna system for inside building radio signal coverage is provided. This antenna system will be used by the Operations, Maintenance and Security radio system. Should any transmission or control lines be faulted, depending on the faults location and nature, a portion of the system will still be operative.

All radio stations and auxiliary equipment are located in air-conditioned, limited access areas. The radio system includes portable units with repeaters and built-in antennas, as well as a control console in the Main Control Room, Auxiliary Control Room, Waste Processing Control Room, Central Alarm Station, and the Secondary Alarm Station. The radios operate on a dedicated, assigned frequency and provide maximum plant coverage.

9.5.2.4 System Operation

Working stations which may be used during transient events are shown in Table 9.5.2-1. Communication facilities are provided between these working stations and the Main Control and Auxiliary Control Rooms and emergency facilities to mitigate the consequences of transient, accident and fire conditions.

Communication between personnel performing cold shutdown can be established by the use of the installed PABX system, the installed sound powered telephone system or the portable radios routinely used by operations and maintenance personnel. Adequate manpower will be available to complete all necessary action in the time required to bring the plant to a stable cold shutdown condition following a postulated fire in any single fire area.

All areas meet the Occupational Safety & Health Administration noise requirements which are 115 db(a) for emergency and transient conditions and 90 db(a) for normal conditions.

The auxiliary control room's communication capability is identical to the main control room capability with the exception of Emergency Telecommunications System (ETS) telephones which are not installed in the Auxiliary Control Room. A sound-powered phone circuit and a telephone/PA circuit exist between each control room and all levels of the Containment Building and the Reactor Auxiliary Building. The Fuel Handling Building also has telephone/PA

communication on each level, and sound-powered communication is available on the lower four levels.

Convenient, emergency access to sound-powered phones and telephone circuits exists as shown in Table 9.5.2-2. A dedicated fuel handling sound powered circuit also exists between the main control room, the containment building 286 ft. level, and the fuel handling building 286 ft. level.

The following criteria are used to maintain reliable, distinct, and clear communication between the Control Room and Auxiliary Control Room and the referenced working stations having the indicated background and/or maximum noise levels:

1) Areas with noise levels above 100 Decibels, db(a)

   a) For telephone stations, a soundproof booth or acoustical shield and a noise cancelling microphone in the handset instrument are provided.

   b) The paging system coverage is reinforced by an increased number of loudspeakers with additional audio power (through line matching transformers).

   c) Sound powered headsets intended for these areas are provided with a noise shielded microphone and are specially designed to operate clearly in areas with noise levels up to 130 db(a).

   d) Portable handheld radios can be provided with plug-in type headsets furnished with noise shielded microphones, designed to operate in areas with noise levels of 120 db(a) as required.

2) Areas with noise levels between 80 and 100 Decibels, db(a)

   a) Telephones are provided with noise cancelling microphones. A acoustical shield is provided as required for each station.

   b) Paging coverage procedures similar to the ones stated in Paragraph a)2) above are followed.

   c) Sound-powered headsets intended for these areas are provided with a boom microphone designed to operate within this noise level range.

   d) Portable handheld radios can be provided with plug-in type headsets furnished with boom microphones as required.

3) Areas with noise levels below 80 Decibels, db(a)

   a) Communication facilities at working stations located in these areas are individually evaluated to determine if there is a need to provide them with special equipment as noted in Paragraph b) above. If Paragraph b) requirements are not necessary, standard type communication instruments are furnished.

The following communication facilities are provided at or near each working station described in 1), 2), and 3) above:

1) A telephone station

2) A paging speaker

3) A sound-powered jack station

4) Radio communication is also available to those working stations that are able to receive radio signals. An interior antenna system for inside radio signal coverage is provided for this purpose.

9.5.2.5 Communications Equipment Power Supplies

The communication system and its associated power supplies are provided as described below:

1) 120 volt power for the Containment Evacuation Alarm, the Operations, Maintenance, and Security Radio System, and the High Level Intraplant Paging System is supplied from the non-Class 1E Uninterruptible Power Supply (UPS) bus through power distribution panels. The non-Class 1E UPS System consists of rectifier/inverter source. Inverter is normally supplied through its rectifier from a non-Class 1E 480V MCC (1D21). Should this voltage drop below the required level, the inverter is supplied automatically from the 250V DC battery DP-I-250. In addition, each inverter can be bypassed manually connecting the system through the transformers to the 480V non-Class 1E MCC.

   The configuration of the UPS System is shown on Fig. 8.1.3-3 of SHNPP FSAR. The 120 VAC source for the CAS Security Radio System is also from an 80-KVA non-class 1E UPS through Panel UPP-3A. The 80 KVA UPS is supplied from 480 VAC Distribution Panel DP-1A3 and dedicated 480 Volt DC batteries. 480 VAC Distribution Panel DP-1A3 receives its power from 480 VAC Emergency Bus 1A1 or 1B1. Similar to the operation of the UPS previously described, the 80 KVA UPS-Inverter will automatically be supplied from CAS Battery Cabinets if the normal 480 VAC voltage should drop below a pre-determined value.

2) Part of the plant Operations/Maintenance radio communication system is powered from the diesel backed Alternate Seal Injection Motor Control Center.

3) Those portions of the Operations, Maintenance and Security Radio System which are dedicated to security communications are supplied from non-Class 1E Uninterruptible Power Supply through power distribution panels. The UPS consists of a rectifier/inverter source. The inverter will normally be supplied from an MCC in the Security Building. Should a problem result with this feed, the inverter will be automatically transferred to a 125V DC battery. The inverter can be bypassed and the system fed directly from the MCC should it be necessary.

4) Sound Powered Headset Intercom System - Does not require Electrical Power Supply

5) PABX System - During normal plant operation, the PABX is supplied from the Administration Building MCC 1-4A71. Upon loss of this supply, an automatic transfer

switch is provided to reconnect the PABX and associated support equipment to a supply from a Motor Control Center in the Security

Building which is backed up by the auxiliary diesel generator in the Security Building.

A redundant rectifier/charger system backed-up by a single bank of batteries is provided for the PABX system. A disconnect switch is provided to enable the removal of the batteries from the system for maintenance purposes.

6) Microwave Equipment - This equipment is powered from 120 volt service panel SPEB in the Administration Building.

7) Southern Bell - Power is provided to Southern Bell equipment from a 120 volt service panel SPEB.

Besides the reliability provided with each subsystem, the strength of the onsite communication system lies in the overlapping coverage given by the subsystems. Figures 9.5.2-6 details power supplies for the Harris PABX equipment.

9.5.2.6 Offsite Communication

During normal operations, offsite telephone service is provided to the plant by Southern Bell central office trunks and dial tie trunks connected to the CP&L telephone network. In the event that normal commercial telephone service is lost, the central and secondary alarm stations can communicate with the county via the two-way radio system. CP&L's microwave system provides a dial through connection to the public telephone system.

9.5.2.7 Inspection and Testing

Preventive and corrective maintenance programs will be implemented by Carolina Power & Light Company. Communication equipment purchasing specifications require vendors to furnish complete operating and maintenance instructions for power plant personnel use.

A functional test will be performed to assure effective communications between plant personnel in all vital areas during maximum plant noise conditions under various operating conditions. All systems are to be inspected regularly and undergo operational checks to ensure service readiness and effectiveness. Necessary spare parts, tools and test equipment are available.

Communication system protective measures are in some cases built in the equipment, in other instances they are provided in the design of the subsystems. The wiring is sectionalized by areas, floors and/or buildings to facilitate trouble-shooting. Each of the subsystems is provided with a dedicated conduit system with the exception of the following:

1) Telephone and sound-powered cables share a common solid bottom tray system for the communications room area and share the same conduit in underground raceway to the emergency diesel generator building.

2) High-level paging and telephone cable has been installed in separate control raceway for underground installations only.

9.5.2.8 Instrumentation

The following are annunciated in the Main Control Room by a common alarm (Communication System trouble).

1) PABX Telephone System Powerfail.

2) PABX Telephone System Major Alarm

3) PA Zone A trouble.

4) PA Zone C trouble.

5) PA Zone D, E trouble.

All PA system trouble failures can be identified by local alarm indicators located on the PA equipment.

All PABX system trouble failures can be identified by annunciator indications or by alarm indicators on the PABX switch.

9.5.3 LIGHTING SYSTEMS

9.5.3.1 Design Bases

Lighting Systems are designed to provide illumination throughout the plant during all modes of plant operation. The levels of illumination are at or above the minimum average, maintained foot candles as specified in the Illuminating Engineering Society Handbook, fourth edition. Mercury containing illumination sources (fluorescent, mercury, metal halide and high pressure sodium lamps) are typically prohibited in the vicinity of systems that could return mercury contamination to the primary system. The above criteria provides a general prohibition against the use of mercury containing illumination sources in the Containment and areas where fuel is handled. This does not include the entire Fuel Handling Building. Individual exemptions to the general prohibition shall be minimized, but can be allowed if the particular illumination source design has features to prevent the introduction of mercury into the primary system. Typical designs that may be evaluated as acceptable exemptions include, but are not limited to, the following:

a) explosion proof housings

b) protected and encapsulated bulb designs

c) armored and waterproof housings

Exemptions will be documented on a case by case basis using appropriate engineering documents. If under unusual circumstances an illumination source should be compromised and mercury was not contained, an engineering evaluation shall be performed, prior to placing the associated plant system back into service. Where mercury illumination sources are prohibited, incandescent sources are utilized.

The lighting systems and their power sources are designed to provide sufficient illumination to enable the plant operators to perform all manual operations required at all times and to move safely through essential areas of the plant.

9.5.3.2 System Descriptions

Plant lighting is divided into three main systems:

a) Normal AC Lighting System

b) Normal/Emergency (N/E) AC Lighting System

c) DC Emergency Lighting: System

Normal AC Lighting System - The normal AC lighting is energized continuously from the plant non-safety related 480V auxiliary system motor control centers through 3 phase, 4 wire, 480 - 480Y/277V or 480 -208Y/I20V dry type transformers. These transformers feed local area lighting panels. The Normal AC Lighting System is operable when the plant is in a normal operating mode or when offsite power is available. The normal operating mode includes the plant startup mode with offsite power available, the plant running mode with the unit auxiliary transformers supplying auxiliary power, and the plant hot or cold shutdown mode with offsite power available. The normal lighting system provides approximately 80 percent of the total plant illumination.

Normal/Emergency (N/E) AC Lighting System - The Normal/Emergency AC Lighting System which is non Class IE, non-Seismic Category I is energized continuously from the plant safety related 480V auxiliary system motor control centers through 3 phase, 4 wire, 480 -480Y/277V or 480 -208Y/120V dry type transformers.

These transformers feed normal/emergency local area lighting panels. The normal emergency lighting is available under all plant conditions. A redundant system consisting of two separate and distinct trains, A and B, of N/E lighting is provided. Upon normal offsite power failure, each train of the N/E lighting load is reenergized automatically from its associated emergency diesel generator source. N/E lighting comprises approximately 20 percent of the normal plant lighting load. Either train of the N/E lighting provides the necessary lighting essential to the safe and orderly operation of the plant during loss of normal AC power. These transformers have been seismically qualified by test.

Normal/Emergency lighting is provided to all plant areas, including those areas required for safe shutdown of the reactor and evacuation of personnel in the event of an accident, except for Turbine Building Elevation 314 ft., the Yard Area, Security Complex (RAB 286'), and the Hot Shop Area (RAB 236'). The Yard Area is serviced by security lighting.

Appropriate isolation is provided between the non-safety related N/E lighting and the safety related equipment.

DC Emergency Lighting System - The DC Emergency Lighting System, which is non-Class IE and non-Seismic Category I, provides illumination during loss of either train of the normal emergency lighting sources in the Control Room, the auxiliary control room, and the computer room. The source of power for the DC Emergency Lighting System, which is automatically

energized upon loss of either train A or B of the normal/emergency lighting system, is the station 125V non-safety battery. Operation of the DC Emergency Lighting System is annunciated in the Control Room to prevent accidental depletion of the battery.

In the balance of plant areas, DC emergency lighting is provided by self-contained storage battery lighting fixture assemblies.

9.5.3.3 Safety Evaluation

Lighting systems provide illumination throughout the plant during normal and abnormal plant operation. Upon loss of normal power, the DC Emergency Lighting System is automatically energized. Approximately 10 seconds after the loss of normal AC power, the redundant AC Normal Emergency Lighting System (A and B) receives power from the standby diesel generators so failure of one system will not result in failure of the other system, and the DC Emergency Lighting System is automatically de-energized. The DC Emergency Lighting System is automatically energized in the event that the redundant AC Normal/Emergency Lighting System fails.

SHNPP is designed such that the plant can be brought to, and maintained in, a safe shutdown condition from the Main Control Room (MCR). The normal emergency lighting in the MCR is seismically designed to assure sufficient lighting is available for manual operator actions following a SSE. In addition, adequate lighting is provided throughout the plant to meet the requirements of Section C.5 of BTP CMEB 9.5-1. These provisions are further enhanced in the control room by providing a support system for the lighting and suspended ceiling that has been seismically designed for the design basis seismic event. In all other safety related areas of the plant, seismically designed lighting supports are utilized in locations where their failure would adversely affect safe shutdown of the reactor.

The source of power for the Normal Emergency Lighting System is Class 1E and can be powered from the Station Diesel Generators. In addition, the portion of the Normal Emergency Lighting System that feeds the MCR is redundant and seismically designed. This includes the cables, conduits, and light fixtures.

Seismic adequacy is provided for the lighting panels by their similarity to seismically qualified panels utilized in the Class 1E MCCs. These panels are fabricated by the same vendor and from observation and inspection are the same as the panels in the 1E MCCs. The Control Room lighting panels are seismically wall mounted and would experience less dynamic acceleration than the similar panels within the 1E MCCs.

Seismic adequacy has been provided for the Control Room lighting transformers by test. The transformers are seismically floor mounted. The above measures are more than satisfactory to ensure the Control Room lighting remains functional following a SSE event.

The emergency lighting system consists of two independent systems: normal/emergency AC lighting and DC emergency lighting. The normal/emergency AC lighting is divided into two independent trains, each of which is connected to its associated diesel generator and corresponding safety division. Either independent train can provide adequate lighting to cover the areas shown in Table 9.5.3-1 for the safe and orderly operation of the plant during my mode of emergency operation.

The normal/emergency AC lighting normally receives power from the station safety-related auxiliary power system through the unit auxiliary transformers or start-up transformer. In the event of the loss of offsite power, the power to the lighting system is provided from the onsite diesel generators. This design precludes the complete loss of lighting in the control room and other vital areas due to a single failure in any one of the safety divisions of its associated diesel generator. Figure 9.5.3-1 identifies the various devices utilized for the normal/emergency AC lighting.

The DC emergency lighting system provides lighting in areas as shown in Table 9.5.3-1 which includes the control room, the auxiliary control room, and the computer room. The DC emergency lighting for the control room, auxiliary control room, and computer room is fed from the station non-safety DC batteries and is energized automatically in the event of loss of AC power in either train A or train B of the normal/emergency AC lighting. This design allows lighting the control room during switchover from normal AC power (thru station auxiliary transformers) to the onsite emergency power (the diesel generator). Figure 9.5.3-2 identifies the various devices utilized for the DC emergency lighting for the control room, auxiliary control room, and computer room.

9.5.4 DIESEL GENERATOR FUEL OIL STORAGE AND TRANSFER SYSTEM

The function of the Diesel Generator Fuel Oil Storage and Transfer System (DGFOSTS) is to store, maintain, and supply fuel oil to the standby diesel generators as required for all modes of diesel generator operation during normal and abnormal site and plant conditions.

9.5.4.1 Design Bases

The DGFOSTS design is based on the following requirements and criteria:

a) The onsite storage capacity of the system provides sufficient fuel oil for continuous operation of each diesel generator at maximum rated load for at least seven days.

b) The system ensures the availability of fuel to at least one of the two diesels assuming any single active or passive failure of one of its components.

c) The system is designed to Seismic Category I requirements and as such will remain functional during and after the safe shutdown earthquake (SSE).

d) The system is protected from the effects of other natural phenomena including the probable maximum flood, the design basis wind loading, and the design basis tornado.

e) The system is protected from the effects of internally generated missiles, high energy line breaks and through wall leakage cracks associated with moderate energy pipe ruptures.

f) Redundant elements of the system are physically separated to the extent necessary to ensure that no single active failure in the system will affect redundant components.

g) All system components are designed and arranged to permit inspection, cleaning, maintenance, and repair of the system.

h) The system is designed to minimize the chance of deleterious material from entering the system during refilling periods.

i) The emergency Diesel Fuel Oil Storage and Transfer System complies with all requirements of ANSI Standard N195-1976, "Fuel Oil Systems for Standby Diesel Generators," except for the following:

    1) "An over-flow line from the day or integral tank to the supply tank shall be provided."

    2) The fill line shall include such design features and administrative control that protection is provided from accidental contamination.

j) The emergency Diesel Fuel Oil storage and transfer system complies with the requirements of ASTM D975-81. Except that the analysis for sulfur may be performed in accordance with ASTM D1552-79 or ASTM D2622-82.

Each day tank is provided with two class IE, seismic Category I level switches. Day tank overflow will be prevented by either switch. The full-lo switch will stop the pump on a full level signal and the hi-hi level switch will close the inlet day tank valve on hi-hi level signal. In the unlikely event that the fuel oil transfer pump fails to stop on a day tank full level signal and the solenoid valve at the day tank inlet fails to close on a hi-hi level signal, the fuel oil will flow out of the day tank through an overflow line to the day tank cubicle. The day tank cubicle has a drain system that includes a normally closed valve. Drainage of this area can occur via opening of the normally closed valve in conjunction with operation of the diesel generator sump drain system as shown in Figure 9.5.5-2. The sump pump discharges to an oil separator unit (located in the yard) for eventual disposal. All floor drains, sump pumps, and oil separators are not required to function after a design bases accident and are therefore designed as non-seismic Category I. In the event of a failure of the non-seismic Category I systems, safety-related systems will not be adversely affected but will remain functional as required.

The diesel fuel oil transfer pumps are provided with a single basket strainer in the pump suction line. The strainer was conservatively sized and the pressure drop across the strainer is negligible at the design flow rate even when the strainer is 30 percent clogged (ref. CAR-SH-M-049Z). Therefore, clogging during seven days of operation of the diesel generator is unlikely. However, for pump protection, the suction line is provided with a flow switch to alarm abnormal conditions.

Although the diesel fuel oil storage tanks do not include specific design features such as a diffuser pipe on the fill line, it is highly unlikely that diesel engine operation will be impaired by sediment carry-over resulting from turbulence caused by tank refill. As described in Sections 9.5.4.3, 9.5.4.5, and the Technical Specifications, the quality of the fuel oil is subject to surveillance and periodic sampling. This assures that fuel oil is of high quality. The inspection and testing minimizes the possibility of introducing contaminants into the storage tanks and assures the detection of fuel oil contamination in a timely manner so that corrective action can be taken.

Additionally, since the storage tanks are normally refilled before the tank level is reduced to a 7-day reserve capacity, assuming the rated load consumption rate for diesel operation, the refill operation will occur before the tank inventory drops to approximately 88,000 gallons which

includes unusable fuel oil inventory. Since the oil level is high, refill turbulence is not expected to disturb sediment in the tank. In the event that a diesel fuel oil transfer pump suction line becomes clogged, a manually-operated bypass line is provided. This ensures that fuel oil can be supplied to the respective day tank in the event that the strainer continues to be unavailable.

9.5.4.2 System Description

The system consists of two separate, independent fuel oil supply subsystems, each serving one of the two standby diesel generator engines. Each of these redundant subsystems consists of one fuel oil storage tank, one transfer pump, one day tank, interconnecting piping valves, and associated instruments and controls. The flow diagram is shown on Figures 9.5.4-1 and 9.5.4-2.

The fuel oil from the main fuel oil storage tank is supplied to each day tank by the fuel oil transfer pump as shown in Figure 9.5.4-1.

The diesel engine mounted piping and components consisting of an engine driven fuel oil pump, a duplex strainer, an ejector system, an injector system, manifolds, and valves (check, shut-off and relief valves), is shown in detail on Figure 9.5.4-2. Pressure and level switches and gauges are provided for alarm, control, and indication.

Upon receipt of a signal initiating diesel start, the diesel engine shaft driven fuel pump takes suction from its associated day tank through a duplex strainer and discharges fuel oil to the diesel engine through a check valve and duplex filter. A relief valve is provided to protect the system.

Leaving the duplex filter, fuel flows to the supply header and circulating header. Fuel is then fed to each cylinder fuel injector. The governor controls the fuel racks which in turn regulate the amount of fuel injected to the cylinders, thus controlling the engine speed. Since the fuel oil pump is sized to pump more than the engine needs (26 gpm) fuel oil not used by the injectors is returned to the day tank by means of an ejector system. The ejector system regulation is controlled by a pressure regulator (set at 40 psig) which is mounted on the day tank.

The diesel engine fuel oil system, as shown on Figure 9.5.4-2, is divided into three subsystems.

a) The fuel supply subsystem is composed of a fuel pump suction side duplex strainer, a constant speed engine driven positive displacement supply pump, a fuel pump discharge side duplex filter, supply header piping to conduct fuel to the fuel injection pumps and nozzles provided for each individual cylinder. The engine driven supply pump is sized to provide approximately 2 1/2 times the required fuel for combustion at 110 percent load, in order to insure adequate injection pump fill, and to cool the injection pump. Fuel oil is supplied under positive pressure to the supply header from which the injection pumps take suction. Uninjected fuel is returned to the day tank.

b) The fuel return subsystem is composed of supply header, circulating header, piping for fuel oil return to the day tank, and a pressure regulating valve. This subsystem conducts uninjected fuel to the day tank through two paths. The uninjected fuel is returned to the supply header where excess fuel is returned to the day tank through a pressure regulating valve at the day tank via the fuel oil return connection. The pressure regulating valve in conjunction with the engine-driven supply pump delivered quantity,

fuel used for combustion, and bypassed fuel, controls the supply pressure within an acceptable range required for proper system operation.

The second pathway involves the return of fuel oil which has been directed to the circulating header. The injection pump primary (or fill) cavity has a 1/16 inch diameter orificed fitting installed. The fuel that is bypassed via the 1/16 inch injector orifice provides cooling of the injector pump and is collected in the circulating header which is maintained at a positive pressure. The oil pressure in the circulating header is slightly less than the supply header but at a sufficient positive pressure for return to the day tank via the fuel oil bypass outlet connection.

c) The fuel leakage collection subsystem is composed of piping from the supply and circulating headers, a drip header, ejector, and a two-way, two position hydraulic, pressure-activated valve (Humphrey valve). The injection pumps and injector nozzles are mechanical devices and have no positive sealing arrangement other than very close metallic fits. During system operation, a very small portion of fuel is expected to leak past these parts under the very high pressures of injection. The fuel leakage could cause damage, in time, if it was allowed to drain into and collect in the engine crankcase. In order to avoid this potential source of damage, the engine is equipped with a fuel leakage collection subsystem which directs leaking (dripping) oil from the injector pump and injectors to a drip header. Since the day tank is located above the elevation of the engine driven pump to insure flooded pump action, some motive force is required to remove and return the drip fuel to the day tank. The diesel engine fuel oil system utilizes the motive force of the large quantity of by-passed fuel to return the drip fuel to the elevated tank. By connecting the supply header to the power port of a small high reliability, no-moving part ejector, the supply side of a two-way/two-position hydraulic pressure activated positive shutoff valve (Humphrey valve) and drip headers to the suction port of the ejector via the positive shutoff valve (Humphrey valve), dripped fuel oil is removed and returned to the elevated day tank.

The ejector system acts like a jet pump providing suction for drawing drip oil from the drip header through the Humphrey valve. The ejector operates as high pressure oil is admitted to the power port of the ejector. This high oil pressure is also used by the Humphrey valve which overcomes the "spring force" of the valve diaphragm, thereby opening the valve and admitting oil from the drip header to the suction port of the ejector. In the absence of a sufficient differential positive pressure across the valve diaphragm, the Humphrey valve remains closed and no oil is drawn from the drip header.

The use of an ejector eliminates the need for a separate electrical pumping system with its associated tank, level sensing equipment, motor controls, and cabling. The positive shutoff Humphrey valve insures that in the event of a return line obstruction, bypassed fuel cannot backflow into the drip headers. The use of a check valve in the drip fuel line upstream of the suction port of the positive pressure actuated shutoff valve (Humphrey) provides additional assurance that if one device fails (Humphrey valve) the other (check valve) will protect. Even if the drip header should back up, the engine will continue to operate since a vent in the drip system would divert the oil and prevent the fuel from entering the crankcase.

The two fuel oil storage tanks are horizontal, reinforced concrete tanks with steel liners, located underground in the yard and designed to Seismic Category I requirements. Fuel

consumption of the diesel generator at rated load is 445 gal/hr. Each fuel oil storage tank will contain enough diesel fuel for continuous operation of the diesel generator for seven days at rated load plus adequate additional capacity for testing in accordance with ANSI N195-1976. A comparison of design basis fuel oil consumption and fuel oil storage tank capacity is shown in Table 9.5.4-1. This storage capacity provides ample time for obtaining additional fuel oil, since additional fuel oil is readily available within eight hours. See Section 9.5.4.6 for a discussion of local sources of fuel oil. Fuel delivery to the plant is by rail car or truck. Two rail car fuel oil unloading pumps are provided for the two fuel oil storage tanks. The fuel oil unloading pumps transfer the fuel oil from the delivery vehicle to the fuel oil storage tanks. Two connections are provided so that fuel can be received from trucks. The unloading of diesel fuel oil from the tank car or truck is performed under administrative controls. Control procedures will ensure that the diesel fuel oil unloading pump(s) discharge valve(s) are locked open prior to pump operation. In the event the unloading pump(s) are started with the tank valve(s) closed, the fuel oil refill line relief valve will lift and divert the oil around the closed valve to the downstream side of the fill line. Flow and pressure instrumentation on the fuel oil unloading lines will provide local indication to an operator to alert him of improper system operation.

The diesel fuel oil transfer pump is a horizontal, centrifugal pump located below grade in a separate compartment adjacent to the fuel oil storage tank. The fuel oil transfer pump powered by its associated diesel generator is sized to provide a flow of 40 gpm for approximately six times the maximum engine consumption rate and is automatically controlled through the use of a level switch activated by day tank fuel level. Upon demand, the diesel fuel oil is pumped from the fuel oil storage tank and through one simplex strainer into the diesel fuel oil day tank. A recirculation line is provided at the discharge of the fuel oil transfer pump to protect the pump in the event of flow blockage. A bypass line is provided around each fuel oil transfer pump suction strainer.

In each fuel oil supply subsystem, the fuel oil transfer pump maintains the fuel oil level in its associated diesel generator day tank. The day tanks are vertical steel tanks located in separate, isolated, fire resistant compartments, and situated so as to assure sufficient positive pressure at the engine fuel pumps. The volume of each day tank provides approximately six hours of storage assuming maximum engine fuel consumption. The tank drains and overflows to the building floor drain system and is then delivered to an oil separator unit located in the yard for eventual disposal. This arrangement is acceptable since sufficient margin is provided between day tank high-high level signal and the overflow connection to allow for thermal expansion of the contents without overflow. In addition, if the fuel oil transfer pump fails to stop upon receipt of high day tank full signal, the solenoid operated valve, located in the inlet to the day tank, will close on hi-hi level signal thereby preventing overflow.

The diesel day tank enclosures are provided with exhaust ventilation to the outside, with three hour fire rated walls and doors and can contain the maximum oil spill resulting from a day tank failure. Day tank cubicle access is via stairs to a platform 3 ft. above the finished floor as shown in Figure 1.2.2-87. This design provides sufficient volume for any postulated day tank leakage and therefore limits the potential leakage from the cubicle to the diesel generator area.

Upon receipt of a signal initiating diesel start, the diesel engine shaft driven fuel pump takes suction from its associated day tank and pumps fuel oil to the diesel as required and recirculates that portion not consumed by the diesel back to the day tank. A manual isolation valve is located at the day tank nozzle in the fuel oil supply piping to the diesel engine.

Design parameters for the system components are listed in Table 9.5.4-1.

9.5.4.3 Safety Evaluation

The Diesel Generator Fuel Oil Storage and Transfer System (DGFOSTS) is a safety related system required to support diesel generator operation following loss of offsite power under all postulated conditions.

Each redundant fuel oil storage tank provides the design basis onsite storage capacity for its associated diesel. A single failure analysis of the system is presented in Table 9.5.4-2.

All fuel oil piping commencing at the first flange outside the main fuel oil storage tank and continuing up to the diesel engine mounted piping and components is designed in accordance with ASME Boiler and Pressure Vessel Section III, Code Class 3 as indicated in Table 3.2.1-1. The engine-mounted fuel oil system piping and components meet the guidelines as stated by the DEMA standards. The design stresses, which include mechanical, pressure, and thermal and seismic induced loads for the engine-mounted piping, have been determined by the Diesel Generator manufacturer, Transamerican DeLaval Incorporated (TDI), to be well within the allowable stresses as permitted by ANSI B31.1. Figures 9.5.4-1 and 9.5.4-2 show the fuel oil piping schematic.

Fuel oil supply piping to the main fuel oil storage tank is non-safety related and not required to support the operation of the diesel generator. This piping enters the top of the fuel oil storage tanks and will not cause a leak if a break occurs. The fuel oil supply piping is physically remote from essential systems and components. There are no adverse consequences from supply piping failure since the Diesel-Generator Fuel Oil System is safety related, redundant, and satisfies the single failure criterion. Redundant fuel oil piping for trains A and B is routed in physically separated pump and day tank rooms. Therefore, if one train of piping is postulated to fail, the other diesel generator will be available. The fuel oil storage system provides the design basis onsite storage capacity. Each tank is provided with a manway located on the top which could be used to fill the tank. Non-ASME, Section III, Class 3 tank penetrations are embedded in the reinforced concrete walls of the storage tank. The piping interfacing with the fuel oil storage tank liner is B31.1, A-106 GrB up to the mating flange which is ASTM A-105. An analysis of the non-safety portion of the system provided results that were within the allowable limits of the ASME Code, Section III, and is therefore functionally equivalent to ASME Section III. The piping interfacing with the liner is subject to the QA requirements of general power piping and non-destructive examination as applicable.

The DGFOSTS, except for the fuel unloading pumps, the fuel oil storage tanks, the fuel oil transfer pumps and associated piping and valves, is located within the confines of the Diesel Generator Building as shown on

Figure 9.5.4-1. The Diesel Generator Building is designed to withstand the effects of the safe shutdown earthquake, the design bases tornado, the probable maximum flood with the

associated wave runup, and the design bases wind as discussed in Chapter 3. This precludes damage to protected portions of the system from these sources.

Those components not within the Diesel Generator Building are protected against design basis natural phenomena as follows:

a) The fuel oil unloading pumps and associated piping require no protection since an alternate means of filling the fuel oil storage tank is provided in the form of a manway located at the top of each tank;

b) The fuel oil storage tanks, and fuel oil transfer pumps with associated piping and valves are located below plant grade. This combined with the reinforced concrete design of the storage tanks and transfer pump rooms assures protection from tornado effects. These components are also designed to withstand SSE effects;

c) The fuel oil storage tanks' vent and fill pipes are located at an elevation so as to provide design flood level protection, and protection from maximum net water accumulation for design storm conditions in the plant area. The fuel oil storage tank vent is equipped with a flame arrestor, which provides fire protection, and is located within a concrete enclosure which provides protection from tornado missiles; and

d) The only buried piping (labeled yard on Figure 9.5.4-1) in the DGFOSTS is cathodically protected and protected from missiles by approximately five feet of earth cover. Refer to Section 3.5 for missile protection of buried components.

The routing of fuel oil lines between the diesel oil storage tanks and the Diesel Generator Building is such that they pass under the two railroad tracks, several roadways, and over the circulating water intake and discharge pipes.

The portions of fuel oil lines under the railroad tracks and roadways are located 6 ft. 7 in. below the grade elevation. The circulating water intake and discharge pipes are located 3 ft below the fuel oil lines (measured between the pipe outside diameters).

The fuel oil piping will have a uniform bedding for the entire length of the crossing under the railroad and the roadway. The angle of intersection between the fuel oil lines and the railroad/highway is 90 degrees. The depth of the fuel oil lines underneath the railroad/roadway is such that the combined circumferential stress in the pipe created by the maximum anticipated internal pressure and/or the external loads at the crossing does not exceed the maximum stress allowables for ASME materials.

Calculations using Boussinesg's equation demonstrate that with 6 ft. or more soil cover, the surface loads (external loads) have a negligible effect on pipe wall stresses. It is highly unlikely for a break in the circulation water pipe to undermine the 10-15 foot span required to result in exceeding the allowable stress levels for unsupported two (2) inch fuel oil pipe.

During an SSE, the circulating water pipe will move with the surrounding soil since the pipe is free to move and rotate at each joint. Utilizing the maximum ground velocities and accelerations obtained from the response spectra (Figure 2.5.2-12) the compression and shear wave velocities of the surrounding soil (residual soil data as given in Table 2.5.2-3), and by using the N. M. Newmark paper, "Earthquake Response Analysis of Reactor Structures," November

1971, the displacement of the pipe joints have been determined to be within safety margins. Due to the properties of the soil, i.e., virtually no absorption, and the absence of any driving head, the soil will not wash out from underneath the fuel oil piping. It should be noted that following a Loss of Offsite Power, the non-safety related circulating water system will no longer operate, thereby limiting the area which could be undermined by postulated flooding. Additionally, the diesel generator fuel oil day tanks allow approximately 7 hours of uninterrupted operation without makeup at the maximum rate of consumption. Manual day tank replenishment could be initiated should the need arise.

The DGFOSTS and associated structures have been evaluated to determine the effects of internally generated missiles, considering separation and compartmentalization of subsystem components. The results show that system equipment and structures are capable of withstanding internally generated missiles without a loss of function in redundant components. The consequences of the limited size wall cracks in the moderate energy fire protection system piping within the complex have been evaluated and are acceptable.

Diesel Generator trains A and B are completely separated from each other by a twenty-four inch thick reinforced concrete wall. There are no openings located in this wall. This concrete wall will provide adequate missile protection and physical separation between the two redundant diesel generator units.

The Diesel Generator design also incorporates an overpressure protection system in order to minimize the occurrence of internally generated missiles. Each starting air receiver tank is provided with a relief valve normally set at 275 psi. The diesel generator lube oil system is protected from overpressure events by the use of an internal relief valve normally set at 70 psi. The engine crankcase pressure is provided with a pressure switch which initiates an alarm in the control room on high pressure. The engine is also provided with relief vents and valve covers which will operate in case of high crankcase pressure. In addition to these overprotection devices, the twenty four inch thick concrete wall is considered to be an adequate barrier for any credible missile.

Missile protection is discussed in Section 3.5. High and moderate energy piping systems, criteria for protection against postulated breaks, and evaluations are discussed in Section 3.6. Flood protection measures for Seismic Category I structures and components are discussed in Section 3.4.

In the unlikely event that normal fill lines are damaged and fuel oil must be added to the storage tank to support operability of the diesel generators, steps will be taken to restore the normal fill lines or to use the tornado missile protected penetrations as alternate fill/vent locations. Such steps would be required within seven days if both diesels are operating at full load (i.e., offsite power not restored within 7 days). The alternatives are removing the manway hatch cover to add fuel oil to the tank or using the normal ventline for filling and the level instrumentation penetration as a vent. Preparation for filling the tank under abnormal circumstances would be controlled by written work requests or other written instructions, as appropriate.

Check valves are provided in the Floor Drain System at each fuel oil transfer pump compartment to prevent backflow to the various pump compartments.

Check valves and drain piping arrangement for the diesel generator area sump pump discharge as shown in Figure 9.5.5-2 prevents adverse interaction between the redundant diesel generator areas.

A sump is provided at the low point of each fuel oil storage tank to accumulate water and other contaminants. The bottom floor of the tank is sloped towards the sump which is located away from the transfer pump suction line nozzles (see Figure 3.8.4-22). A drain connection is provided at the bottom of the sump for water and/or sludge removal.

A program for regular surveillance of the quality of the stored fuel oil is included in the Technical Specifications. Growth of algae in the diesel fuel oil storage tank will be prevented by use of a fuel additive containing a biocide. If algae growth is detected in the diesel fuel storage tank, analyses shall be conducted to quantify the amount of algae. If the buildup is minimal, the algae shall be removed through the supplemental use of a biocide additive, in addition to disposal of the tank sediment. If the algae buildup is heavy, the diesel fuel shall be disposed and the storage tank walls shall be cleaned. If in the unlikely event the fuel oil quality falls below an acceptable level, tank drain connections are provided in each fuel oil transfer pump compartment for removing fuel oil by means of mobile pumping units. This assures that the fuel oil will be of satisfactory quality at all times.

The individual diesel day tanks are located within three hour fire barrier cubicle walls with same rating fire doors. The diesel oil tanks are each located in individual cubicles in the Diesel Generator Building, thus separating them from potential ignition sources such as high energy electrical lines and hot surfaces such as the diesel exhaust lines. Each tank is vented outside the building, and is protected from fire by a flame arrestor. The connecting fuel oil piping is routed to minimize exposure to these ignition sources. Automatic fire detection and extinguishing systems are provided for diesel generator units and diesel fuel oil transfer pump area. For a detailed description refer to Section 9.5.1.2.

The two reinforced fuel oil storage tank structures are located below grade more than 50 feet from the nearest building in excess of the minimum distance called for in NFPA 30, "Flammable and Combustible Liquids Code." Thus, in the unlikely occurrence of a fuel oil storage tank fire, the effect of the fire will be confined to the area of the tank and will not affect reactor operation and safety.

A three-hour firewall separates each of the fuel oil transfer pumps, thus ensuring that a single event such as a fire will not cause the failure of more than one pump. Due to the non-explosive characteristics of diesel oil, if in an unconfined atmosphere, an explosion is not considered a credible occurrence.

The fuel oil storage tank liner will be coated with 3 to 5 mils of inorganic zinc primer to protect against corrosion. The liner will be cleaned and sandblasted prior to coating. Following are the applicable industry standards:

SSPC-PA-1	Shop Field and Maintenance Painting
SSPC-PA-2	Measurement of Dry Paint Thickness with Magnetic Gauges
SSPC-SP-3	Power Tool Cleaning

SSPC-SP-10 Near-White Blast Cleaning.

Buried field oil piping will be provided with a cathodic protection system and either coated with hot applied coal tar enamel and asbestos felt or wrapped with plastic tape. Properties of hot applied enamel are per AWWA Spec C-203, Section 2.2.

Physical properties of asbestos felt wrap materials are per AWWA Spec C-203, Section 2.6. Tape material shall be 20 mil pressure sensitive tape such as Scotchwrap #51, Trantex #V-20 or equal, 2 in. wide and 1/2 in. lap.

9.5.4.4 Instrumentation Application

The control of each subsystem is identical. Control schemes maintain the proper supply of diesel oil in each day tank by means of interlocks between the full and low level switches in the day tank which stop and start the corresponding fuel oil transfer pump. The Main Control Room is provided with high and low-low level alarm annunciators and level indication for both day tanks and high and low alarm annunciators for both fuel oil storage tanks. Control switches are provided on the diesel engine control panel and the MCB for remote control of each complete transfer system train.

Each day tank has a set of two Class 1E, seismic Category I level switches. One switch provides a full-low level signal and the other switch provides a hi-hi level signal. Day tank overfill will be prevented by either switch. The full, lo level switch will provide a fuel oil transfer pump shutoff on a full level signal and the day tank inlet valve will be closed on a hi-hi level signal from the hi-hi level switch. Therefore, the safety grade day tank instrumentation will preclude the overfill event.

Each day tank is provided with controls, alarms, and indication on its respective diesel engine control panel and on the main control room panel to:

a) Open supply valve and start transfer pump on low-level

b) Stop the fuel oil transfer pump on full level

c) Energize a control room and a local annunciator on lo-lo level

d) Energize a control room and a local annunciator on hi level

e) Close supply valve on hi-hi level

f) Monitor oil level by a control room and a local level indicator

Each diesel fuel oil storage tank is provided with a level indicator which gives level indication on the fuel oil storage tank panel located near the fuel oil unloading pumps. Control switches are provided on the fuel oil storage tank panel for control of the fuel oil unloading pumps.

Each of the fuel oil transfer pump strainers is equipped with a suction flow switch which causes an alarm in the Control Room whenever the low flow setpoint is reached. Each fuel oil transfer pump discharge line is provided with a pressure indicator. The fuel oil transfer system is shown on Figure 9.5.4-1.

Each fuel oil transfer pump and its associated day tank inlet valve is provided with control on its respective diesel engine panel and on the main control panel. Primary control is provided from the Main Control Room. However, control can be transferred to the corresponding diesel engine panel via a selector switch on the diesel engine panel. If the Main Control Room is evacuated and plant control is transferred to the auxiliary control panel, then control of the DGFOSTS will automatically be transferred to its respective diesel engine panel.

In addition, the engine driven fuel pump, as shown on Figure 9.5.4-2, is provided with duplex strainers. The duplex strainer, on the engine driven fuel pump suction side, incorporates a pressure differential alarm to warn of filter plugging. This alarm is annunciated in the control room along with other trouble alarms.

Instrumentation and Control Design Criteria are discussed in Section 7.3.

9.5.4.5 Inspection and Testing Requirements

The system is tested in conjunction with the periodic diesel generator test in accordance with the Technical Specifications. The system is subject to the in-service inspection requirements of ASME XI in accordance with 10 CFR 50.55a(g) (refer to Section 6.6). Manways are provided to allow inspection of the buried fuel oil storage tanks and their instrumentation, and allows access for tank cleaning if required. The access hatch to the tank manways is shown in Figure 3.8.4-22 (intersected by Section A-A on elevation 263.00 ft.). The system components are inspected and cleaned prior to installation. System instrumentation and control signals will be tested during the periodic diesel generator tests as described in Section 8.3.1.1. System instrumentation loop checks and setpoint calibrations will be performed in accordance with the SHNPP Preventive Maintenance program schedule. When the day tank level reaches the "lo" level setpoint, the fuel oil transfer pump is automatically started to raise the fuel oil day tank level to full. Fuel oil transfer pumps are operated and tested during plant preoperational testing. Fuel oil transfer pumps are operated and tested initially to check factory test curves and to determine the initial pump characteristic as installed. Periodically during normal Unit operation, fuel oil storage tank levels are checked at diesel fuel oil unloading station and day tank levels are checked on the Engine Control Panel by means of a manually operated pneumatic level gage. Fuel oil transfer pump and motor availability is checked by conducting a flow test from the storage system to the fuel oil day tank.

Surveillance of the quality of the fuel oil is accomplished by periodic sampling for water and other contaminants in the storage system, and sampling of new fuel oil prior to transfer to the storage system. Sampling procedures shall be in accordance with ASTM Standard D4057-81. Fuel oil samples shall be tested per ASTM Standard D975-81 as described in SHNPP Technical Specifications and shall meet the specifications listed in Table 1 of ASTM D975-81 with exceptions as stated in Section 9.5.4.1.

9.5.4.6 Diesel Fuel Distribution Sources

The primary supplier of diesel fuel is located in Greensboro, North Carolina. The primary distributor has subsidiaries located in other cities, and as needed, these terminals can also deliver fuel to SHNPP. The locations of fuel oil suppliers, their distances from SHNPP, and travel routes to SHNPP are identified below:

CITY	DISTANCE TO SHNPP	TRAVEL ROUTES

Selma, NC	45 miles	US-70
Greensboro, NC	75 miles	I-85; US 1-64
Charlotte, NC	140 miles	I-85
Spartanburg, SC	200 miles	I-85
Wilmington, NC	120 miles	US-421; I-95, S-50; US 70; US 1-64, or US 421; S 55; US 1-64

Because travel routes are major highways, inclement weather will not adversely affect the delivery of fuel oil; routine deliveries have been made under snow, ice, and storm conditions in the past.

In addition to two 3,000 gallon day tanks, the two diesel fuel oil tanks each will be filled to provide sufficient oil to sustain diesel generator operation for seven (7) days at the maximum consumption rate (i.e., 74,760 gallons). In addition to this minimum on-site inventory, delivery schedules can be made in advance thereby assuring an adequate fuel oil supply for long term diesel generator operation.

9.5.5 DIESEL GENERATOR COOLING WATER SYSTEM

9.5.5.1 Design Basis

The Diesel Generator Cooling Water System is designed to:

a) provide full load cooling to the diesel engines in order to maintain proper operating temperatures under all loading conditions,

b) withstand Safe Shutdown Earthquake (SSE) loads without loss of function,

c) assure that a single active failure of any system component, assuming a loss of offsite power, cannot result in a complete loss of functional capability of the diesel generators, and

d) maintain the diesel generator cooling water in a warm condition to facilitate starting.

The diesel generator jacket water heat exchanger is designed to Safety Class 3 and Seismic Category I requirements. Compliance with the requirements of Regulatory Guide 1.68 is described in Section 1.8.

9.5.5.2 System Description

The Diesel Generator Cooling Water System is shown on Figure 9.5.5-1. Component design parameters are given in Table 9.5.5-1.

Each diesel engine is provided with a separate closed loop cooling water system. This system is a forced circulation cooling water type to directly remove heat from the engine by means of jacket water. The closed loop system is designed and supplied by the equipment manufacturer and includes an engine driven jacket water pump, standpipe and heat exchanger with the required interconnecting piping. The closed loop subsystem is equipped with an electric immersion heater and a motor-driven keep-warm circulating pump which maintains the engine in a ready-to-start condition. The tube side of the heat exchanger is supplied with cooling water from the Emergency Service Water System. (The Service Water System is described in Section

9.2.1 and those portions pertaining to the diesel generator are shown in Figure 9.5.5-2). The standpipe is initially filled by the potable water supply. The jacket cooling water circulating pump is an engine driven centrifugal pump, designed to provide cooling water during all diesel engine loadings. The pump draws water from the bottom of the standpipe and discharges through the heat exchanger before entering the diesel engine cooling passages. The standpipe serves two purposes: it is the storage tank for the system, and it absorbs the changes in cooling water volume as the diesel engine heats up and cools down. Makeup to the system is from the potable water supply. Normal water level in the standpipe is above the highest point in the engine (refer to FSAR Section 9.5.5.3).

A three-way temperature controlled valve controls the flow through the heat exchanger to maintain the required water temperature, (170 F to 180 F) during diesel generator operation.

During periods of diesel generator standby, the jacket water cooling system is automatically maintained between 145 F and 170 F by means of an electric jacket water keep-warm heater, jacket water keep-warm thermostat, and a motor driven jacket water keep-warm pump (see Figure 9.5.5-1). High and low temperature alarms monitor the jacket water temperature and the "keep warm" pump is tripped automatically upon start of the engine. The jacket water heater is provided with power from a non-safety power distribution panel in the diesel generator building.

Engine cooling water system design precludes trapping of air within the engine spaces. Vents are provided in the jacket water cooling system standpipe in order to assure that all spaces are filled with water. Provisions are provided to treat the jacket water by adding or removing chemicals. Corrosion and organic fouling are controlled by using suitable chemicals and biocides. The chemicals utilized are compatible with the system materials and each other. The pH of the jacket cooling water is maintained within the recommendations found in the EPRI “Closed Cooling Water” guidelines.

The jacket water heater is conservatively sized and will maintain jacket water between 145 F and 170 F. A description of the Diesel Generator Building Ventilation System is provided in FSAR Section 9.4.5.

The total heat rejection at 110 percent load from the jacket water heat exchanger is 13,696,946 Btu/hr. The heat exchanger is designed to a duty of 13,946,940 Btu/hr based on the parameters listed in Table 9.5.5-1 and 10 percent of the tubes plugged.

9.5.5.3 Safety Evaluation

The Diesel Generator Cooling Water System is designed to have adequate capability to carry away the waste heat from diesel generator units under all loading and ambient conditions. The diesel generator is capable of operating fully loaded without secondary cooling for a minimum of one minute. Sufficient water is contained in the engine and standpipe to absorb the heat generated during this period. The normal supply of cooling water for the diesel generator is the normal service water pump. Upon loss of offsite power the emergency service water pump will supply cooling water to the diesel generator after a period of 20-25 seconds.

The Diesel Generator vendor, Transamerica De Laval, ran a continuous 24 hour load test on a diesel engine-generator set similar to Shearon Harris' unit. The test engine ran for 22 hours at 100 percent load, followed by two (2) hours at 110 percent load. Test indicated that less than three (3) gallons of water was lost due to evaporation, boil off, and minor leaks.

The NPSH requirement for the engine jacket water pump corresponds to a minimum standpipe level of 53 1/16 in. Normal water level is indicated by LI 01DG 2465AS, BS and is maintained above the low water mark by manual addition of potable water. Assuming a standpipe water level of 186 1/2 in. at start of seven (7) days of continuous 100 percent load operation, approximately 400 gallons of water is available between elevation 186 1/2 in. and 53 1/16 in. The standpipe, with a capacity above minimum level of 400 gallons, provides more than adequate water to maintain the required pump NPSH and make-up for seven days of continuous operation.

All components of the Diesel Generator Cooling Water System are designed to Seismic Category I requirements. The jacket water heat exchanger and connections to the Emergency Service Water System are also designed to Safety Class 3 requirements. Failure of any non-Seismic Category I structures and components will not affect the safety related performance of the system. The diesel engine-mounted cooling water system piping and components meet the guidelines as stated by the DEMA standards. The design stresses which includes mechanical, pressure, thermal, and seismic induced loads for the engine-mounted piping have been determined by the Diesel Generator manufacturer (i.e., Transamerica DeLaval Incorporated (TDI)) to be well within the allowable stresses as permitted by ANSI B31.1.

The TDI approved QA/QC program used in conjunction with the manufacture of diesel engines, engine-mounted components, and piping comply with the requirements of Appendix B of 10 CFR 50.

Each diesel generator has its heat exchanger's tube side connected to the respective emergency service water system train. Therefore, a single failure of a component, or the loss of a cooling source will not reduce the safety related functional performance capabilities of the system. The jacket water standpipe is provided with low level instrumentation for leak detection. In addition each diesel generator room is equipped with a sump and sump pump to collect and dispose of leaking fluids within the Diesel Generator Building. The sumps are provided with safety class 1E level instrumentation with annunciation in the Control Room to alert operators of potential flooding. The sump pumps are automatically actuated on high sump level.

This system is housed in a Seismic Category I Structure (Diesel-Generator Building) that is capable of withstanding the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, floods, and missiles. As shown on Figures 1.2.2-86 and 1.2.2-87, each diesel generator is located in a separate room. The protection of safety-related systems from the effects of high and moderate energy piping failures are considered in the design of the diesel generator facility. The facility does not contain any high energy lines but does contain the moderate energy lines of the Emergency Air, Fire Protection, Fuel Oil, Lube Oil, Miscellaneous Drains, Service Water, Potable Water, and Station Air systems. Facility design provides for the effects of failures (cracks) in these moderate energy fluid systems. Flooding from cooling line leaks does not impact other diesel generator areas where the line break has not been postulated. Facility design as shown on Figures 1.2.2-86 and 1.2.2-87, and sump drain design as shown on Figure 9.5.5-2 precludes flooding impact on the unaffected diesel generator area. A further discussion of the postulated piping failures in high and moderate energy fluid systems is located in Section 3.6.

9.5.5.4 Testing and Inspection

The diesel generator jacket system will be tested during the periodic diesel generator tests as described in Section 8.3.1.1, and its standby (keep warm) condition shall be monitored per plant operating procedures. System instrumentation loop checks and setpoint calibration will be performed in accordance with the SHNPP Preventive Maintenance Program.

All maintenance on the emergency diesel generator will be followed by a verified line-up and post-maintenance test in accordance with the surveillance requirements of Technical Specifications. The line-up procedure will verify that the keep-warm system is properly aligned. Testing of the diesel generator operation does not require realignment of this keep-warm system.

The cooling water in the closed loop system is periodically analyzed to monitor its condition and treated as required to maintain its quality.

9.5.5.5 Instrumentation Application

The following alarm points with local annunciation are provided in the Diesel Generator Cooling Water System for each diesel generator:

a) jacket water inlet high/low temperature

b) jacket water outlet high/low temperature

c) jacket water high temperature trip

d) standpipe low level

e) jacket water pressure

f) jacket water low pressure trip

Jacket water pressure switch (PS-22C) and jacket water low pressure trip (PS 21C) are separate pressure switches which are connected to a common process tap (refer to Figure 9.5.5-1).

Pressure settings for jacket water pressure switch is 9 psi and decreasing (alarm point), jacket water low pressure trip switch is 7 psi and decreasing.

Operation of any of the above mentioned local alarms is indicated by annunciation on the Diesel Generator Control Panel and also "trip" or "trouble" alarms on the Main Control Board. In addition, pressure and temperature devices are provided for local indication and thermocouples are provided for remote indication of temperature. Temperature settings for jacket water low temperature inlet/outlet alarm switch actuation is 140 F decreasing respectively. In addition, temperature settings for the jacket water high temperature inlet/outlet alarm switch actuation is 175 F increasing and 190 F increasing respectively. One thermocouple is placed in the piping between the return header and standpipe (jacket water outlet high/low temperature) and the second thermocouple is placed in the piping between the heat exchanger and the diesel engine

(jacket water inlet high/low temperature). A high temperature of 195 F will trip the diesel generator if an engineered safety feature signal is not present.

The jacket water low pressure trip is designed to be an anticipatory trip to protect the diesel from a loss of cooling water if the diesel is started by a non-emergency start. This trip is not functional if the diesel receives an automatic, emergency start signal.

9.5.6 DIESEL GENERATOR AIR STARTING SYSTEM

9.5.6.1 Design Bases

The Diesel Generator Air Starting System is designed to the following bases:

a) Each starting air receiver will supply sufficient compressed air to crank the cold diesel engine five times without recharging the receiver. Each cranking cycle brings the diesel generator up to a speed above that necessary to commence combustion of fuel (50 to 100 rpm).

b) Operate under the same environmental conditions as the diesel generator which it serves.

c) The portions of the air starting system necessary for emergency operation meet Seismic Category I, Safety Class 3 requirements.

d) Complete redundancy so that in the case of a single failure of any component, the diesel generator can be safely started.

The air receivers, piping and valves from the receivers up to the diesel engine are designed to Safety Class 3 and Seismic Category I requirements (refer to Table 3.2.1-1).

The air compressors, separators, and dryers upstream of each dryer outlet check valve are non-safety-related as a loss of starting air pressure will not cause a running engine to trip in emergency mode.

9.5.6.2 System Description

The Diesel Generator Air Starting System is shown on Figure 9.5.6-1. The general arrangement diagram for the Diesel Generator Air Starting System is shown on Figures 1.2.2-86 and 1.2.2-87. There are no interconnections among the systems serving separate diesel generators.

A physically separate air starting system is provided for each of the diesel generators. The starting air system consists of two AC motor driven air compressors, two moisture separators, two air dryers and two air receivers each capable of five cold start attempts. The system is designed such that failure of one receiver will not interfere with the ability of the remaining receiver to deliver the required quantity of air. Each compressor is capable of recharging one receiver within thirty minutes after a discharge corresponding to five starting attempts. Each air receiver is equipped with an air dryer and tank drainage capability.

The two compressor discharges for each diesel engine may be aligned to feed both air receivers through a normally locked closed manual crossover valve. Therefore, either compressor has the capability of filling both receivers. Each air receiver is equipped with a safety valve (set at 275 psig), a drain valve, and isolation valves. The air receivers are maintained at a nominal pressure of 240 psig by automatic starting of the compressor at 225 psig receiver pressure, and stopping at 250 psig.

Each air receiver is connected to the diesel engine starting mechanism independently. Upon receipt of a diesel generator start signal, all start air admission valves are opened simultaneously, delivering air to the air distributors and the individual air start valves in proper sequence, admitting starting air directly into the engine cylinders for cranking. Adequate cranking power is obtained from any one of the start air admission valves. Admission of air to the engine during a test start occurs for a duration of 5 seconds or until engine speed reaches 200 rpm. During emergency starts, admission of air occurs until the engine attains a speed of 200 rpm or until air receiver pressure decreases to 150 psig. With the receiver at 190 psig, the air receiver volume is sufficient to start the engine within the required time based on factory and site test data. Coincident with admission of air to the cylinders, starting air is applied to the governor hydraulic system (governor oil booster is pressurized) to open engine fuel racks to maximum fuel position on emergency (fast) start. Site and engine vendor testing has demonstrated that successful engine starting will still occur should the governor oil booster fail to function. If failure of the governor oil booster occurred, the acceleration time of the engine to rated speed would increase from approximately 7 seconds to about 7.5 seconds. A description of diesel generator starting signals is found in Section 8.3.1.1.2.14.

The starting air dryer has two desiccant filled towers and provides air at a design dew point of 5°F. One tower is used to dry the inlet air while the other tower is being reactivated. An automatic control system reverses the tower's operation and provides continuous drying of the starting air.

Regeneration is accomplished by depressurizing the tower and then purging it with a small amount of dry outlet air at atmospheric pressure. Air flow is upward during drying and downward during reactivation. This limits moisture accumulation to the inlet side of the dryer and provides the driest desiccant at the outlet end of each tower to assure a maximum drying of the air.

The desiccant will retain its ability to absorb moisture for a long period of time under normal service so that generally no maintenance of the towers is required.

The dryer is provided with a pre-filter and an after-filter to prevent contamination of the desiccant and ensure that starting air is free of desiccant carried over from the drying tower.

Air supply to each receiver is provided by a motor driven non-safety related air compressor and is isolated from the receiver by a safety grade check valve. The engine is started by the air in the tank. The compressor is automatically controlled to maintain pressure in the tank by pressure switches provided on the air receivers. Each air receiver is capable of starting the engine at least five times without being pressurized by the compressor.

9.5.6.3 Safety Evaluation

Each Diesel Generator Air Starting System is capable of supplying a sufficient quantity of air from its associated air receivers to ensure a successful starting operation of the diesel engine.

Once an engine has started, failure modes and effects analysis and testing has shown that starting air pressure does not need to be maintained in order to prevent a running engine from tripping in emergency mode.

Each engine has redundant and independent air starting facilities of adequate starting capacity. Each engine can be started by either one or both of the dual train pressurized air starting systems. These air starting systems do not depend on normal plant power or any other plant system for starting power once the air receivers are charged. However, safety related 125V DC power of the same division is provided for initial control, field flashing and solenoid valve operation. The safety related 125V DC power is discussed in Section 8.3.2. Alarms are provided to alert the operating personnel if the air receiver pressure falls below the minimum allowable value specified by the manufacturer. A drain valve for each air receiver is provided to periodically blowdown accumulated moisture and foreign material.

The air starting systems for one diesel are physically and electrically separated from those for the other diesel to assure that no single failure in an air-starting system can lead to a loss of function of the other diesel engine.

The starting air system piping mounted on the diesel engines was designed, manufactured, and inspected in accordance with ASTM standards.

The essential portions of this system external to the engine necessary for emergency operation, which consist of air receivers, valves, instrumentation, associated piping, and tubing are designed in accordance with ASME Boiler and Pressure Vessel Code Section III, Code Class 3, Seismic Category I requirements. The Diesel Generator Air Starting System is housed within a Seismic Category I structure to protect the system from extreme natural phenomena. Failure of any non-Seismic Category I structure or component will not affect the safety related performance of the system.

Protection against postulated piping failures in high and moderate energy fluid system breaks is discussed in Section 3.6.

9.5.6.4 Tests and Inspection

The starting air compressors for each diesel engine shall be periodically started as part of the periodic diesel generator tests as discussed in Section 8.3.1.1. Inspection and scheduled maintenance of system components will be conducted on a periodic basis as scheduled in the SHNPP Preventive Maintenance Program.

The starting air tank effluent will be tested on a quarterly basis for dew point to verify that a stored air dew point of 5°F is met at system pressure, otherwise maintenance shall be performed to restore the stored air dew point.

System instrumentation loop checks and setpoint calibration will be performed in accordance with the SHNPP Preventive Maintenance Program schedule.

For compliance with the requirements of Regulatory Guide 1.68 as related to preoperational and start up testing of the Diesel Generator Air Starting System, refer to Section 1.8.

9.5.6.5 Instrumentation Application

The following instruments are provided in the Diesel Generator Air Starting System for each diesel generator:

1) Pressure switches on each air receiver which control the operation of the corresponding compressor, and

2) local pressure indicator on each air receiver.

The following alarm points are provided in the air starting system, with local annunciation on the Engine Control Panel.

1) Air starting system low pressure (each receiver),

2) Barring device engaged. When the barring device is engaged for maintenance, the diesel engine cannot start.

Operation of any of these alarms is indicated by a "trouble" alarm in the Control Room.

The following indicators are provided on the diesel generator engine control panel (local):

1) Starting air pressure (left bank)

2) Starting air pressure (right bank)

9.5.7 DIESEL GENERATOR LUBRICATION SYSTEM

9.5.7.1 Design Basis

The Diesel Generator Lubrication System (DGLS) is designed to the following bases:

a) To provide essential lubrication to the components of the diesel generator unit during all modes of operation.

b) To have the ability to maintain the required quality of the oil during engine operation.

c) To automatically maintain the temperature of the lubricating oil above a minimum value.

d) To ensure that a single active failure cannot cause loss of both diesel generators.

e) To preclude the possibilities of damage due to natural phenomenon and pipe rupture.

The components required for safety are designed to Seismic Category I requirements.

9.5.7.2 System Description

The Diesel Generator Lubrication System is shown in Figure 9.5.7-1. The Diesel Generator Lubrication System (excluding the engine-mounted piping and components) is designed in accordance with seismic Category I and ASME Boiler and Pressure Vessel Section III Code Class 3, as indicated in Table 3.2.1-1. The engine-mounted lubrication system piping and components meet the guidelines as stated by the DEMA standards. The design stresses which include mechanical, pressure, thermal, and seismic induced loads for the engine mounted piping have been determined by the diesel generator manufacturer (i.e., Transamerica DeLaval Incorporated (TDI) to be well within the allowable stresses as permitted by ANSI B31.1.

The TDI approved QA/QC program used in conjunction with the manufacture of diesel engines, engine-mounted components, and piping comply with the requirements of Appendix B of 10 CFR 50. Design parameters for system components are provided in Table 9.5.7-1.

The system consists of the following equipment (per diesel engine generator set):

a) one engine driven pump,

b) one motor driven standby pump (motor driven auxiliary lube oil pump),

c) one lube oil cooler,

d) three lube oil strainers,

e) two lube oil filters (one duplex filter and one keep warm filter),

f) one lube oil keep warm pump

g) one lube oil prelube electric heater (lube oil heater), and

h) piping, valves and instrumentation

The main circulating lube oil pump is an engine driven screw type pump which takes its suction from a lube oil sump tank located on the auxiliary module, through a strainer and circulates oil while the diesel engine is running.

The lube oil is pumped through the lube oil cooler, filters and strainers before it flows to the diesel engine bearings. The filter is capable of filtering out particulates >10μ. The lube oil system is equipped with two full capacity lube oil filters with replaceable cartridges. Change of these cartridges can be effected while the engine is operating. Heat is rejected via the lube oil cooler, to the Diesel Generator Cooling Water System discussed in Section 9.5.5.

The lubricating oil header pressure is controlled by a pressure regulating valve located in the pump discharge piping. It is set at 50 psig, senses header pressure, and regulates the bypass volume to maintain header pressure at 50 psig.

During periods of diesel generator standby, the lubricating oil is kept at the proper temperature (150°F) by circulating it with a motor driven keep warm pump through an automatically

controlled electric heater located in the lube oil sump tank. This assures optimum viscosity and lubricating properties and provides for pre-start lubrication.

The ASME Section III 100 percent capacity auxiliary lube oil pump is a Class 1E motor driven back-up to the main engine driven lube oil pump. This pump is required to operate only when the engine is running and the main engine driven lube oil pump has failed. The auxiliary lube oil pump is controlled via pressure switches located in the lube oil piping. Manual and automatic control of the auxiliary lube oil pump is provided by a three position control switch (off-auto-start) located locally on the Diesel Engine Control Panel. In the automatic mode, the auxiliary lube oil pump will start whenever the diesel engine is running and lube oil pressure becomes low (e.g., main engine driven lube oil pump failure). The pump will stop automatically when the lube oil pressure at the auxiliary lube oil pump reaches a preset high level (excessive pressure). The status indicating lights for the auxiliary lube oil pump and annunciation is provided at the DG local control panel. All the annunciators on the local Diesel Generator Control Panel are reflashed to the Main Control Boards inside the Control Room. The auxiliary lube oil pump is not required for an emergency start. Power for the auxiliary lube oil pump and annunciation is provided at the DG local control panel. All the annunciators on the local Diesel Generator Control Panel are reflashed to the Main Control Boards inside the Control Room. The auxiliary lube oil pump is not required for an emergency start. Power for the auxiliary lube oil pump motor is provided from the 480V safety related MCC located in the diesel generator building, so that power to the auxiliary lube oil pump will be available during a loss of offsite power. The lube oil system is designed to preclude the entry of deleterious material into the system, at the charging terminal by a 2" hex head plug.

To prevent excessive wearing of the turbocharger bearings due to lack of lubrication before the engine starts, a tap from the keep warm system provides a slow drip of oil onto the bearings.

Admission of air into the lube oil system is prevented by the coolers being located below the generator lube oil level.

The starting sequences for a normal start and an emergency start are the same except that most of the trips associated with the automatic safety shutdown system are disarmed during and after an emergency start. Engine overspeed, generator differential, loss of generator potential, and generator bus faults are the only trips active in the emergency mode.

9.5.7.3 Safety Evaluation

The Diesel Generator Lubrication System is capable of supplying sufficient lubrication to the diesel generators under all loading conditions. All components of this system required for safety are designed to Seismic Category I requirements.

The instrumentation, service, location, and description of alarms provided for monitoring the diesel engine lubrication oil system are provided in Table 9.5.7-2.

If a failure in the system prevents the operation of its associated diesel generator, the remaining diesel generator is not affected.

Each Diesel Generator Lubrication System is housed in the same Seismic Category I structure as its own diesel generator and, therefore, is independent and physically separated from the redundant diesel generator system (Figures 1.2.2-86 and 1.2.2-87). Failure of any non-Seismic

Category I structures and components will not affect the safety related performance of the system.

The system is protected from tornado winds, externally generated missiles, and flooding by virtue of its location inside the Diesel Generator Building. As each lube oil system associated with its diesel generator is located in that diesel generator room with no interconnecting piping, missiles generated by one diesel generator will not damage the lube oil system associated with the other diesel generator. Relief valves, relief doors, and crankcase vents have been provided in order to prevent crankcase explosions and to mitigate the consequences should such an unlikely event occur.

Protection against postulated piping failures in high and moderate energy fluid systems is discussed in Section 3.6. The Diesel Generator Lubrication System is designed by the diesel generator manufacturer. Design parameters for system components are provided in Table 9.5.7-1.

Each diesel will consume 0.6 gallons of lube oil per hour during loaded operation and 101 gallons during a seven day (168 hour) run. This represents a small fraction of the 1500 gallon oil system capacity.

The lube oil sump tank is provided with low level instrumentation for leak detection. The sump level alarm is shown on Figure 9.5.7-1, and it is listed in Section 9.5.7.5. The level alarm setpoint is set at a level corresponding to an oil inventory of approximately 1,300 gallons in the system. In the absence of a level alarm, manual monitoring of the oil sump level will be used to determine if oil addition is necessary. Manual monitoring of the lube oil sump tank level can be performed either locally at the tank using the installed dipstick or remotely from the engine control panel by reading of the tank level indicator. In addition, each diesel generator room is equipped with a sump and sump pump to collect and dispose of leaking fluids within the Diesel Generator Building. The sump pumps are automatically actuated on high sump level. Pump operation is annunciated in the Control Room.

Oil addition to the lube oil reservoir will be performed manually. Oil will be obtained from storage containers kept onsite; these containers will not be stored in the diesel generator building due to fire protection considerations. Lubricating oil can be transferred from storage containers by a manual pump or by a portable, electrically operated pump. Oil may be safely added to the system via the sump tank while the engine is running or with the engine stopped.

9.5.7.4 Inspection and Testing Requirements

For the initial preparation for operation, the system will be flushed and then all filters used during the flushing process will be either cleaned or discarded and replaced.

Testing of the diesel generator is discussed in Section 8.3.1.1. The Diesel Generator Lubrication System is operationally tested during the startup and checkout of the diesel generator. Lube oil pressure and temperature are monitored to ensure operability of the engine driven pump. Operation of the lube oil keep warm and sump removal pump and electric heater are evidence of their operability. Inspection and testing of the system can be performed without disturbing normal plant operations.

Representative oil samples will be submitted to a qualified laboratory for analysis on a periodic basis to ensure that the engine manufacturer's specifications are met. The samples will be analyzed for the following: viscosity, dirt (e.g., insoluble materials, resinous matter, external contamination, carbonized or corrosive materials), water, wear metals and acidity. A review of these analysis results by Carolina Power and Light, the oil supplier, and the testing laboratory will be the basis for deciding whether or not the oil needs to be changed.

The diesel generator lubrication system instrumentation loops will be checked and setpoint calibrations will be performed in accordance with the SHNPP Preventive Maintenance Program Schedule. The reliability of the electrical circuitry, with the associated alarms, interlocks, and trip activation signals, will be tested on the same frequency as the associated instrument by simulating the alarm/trip condition.

9.5.7.5 Instrumentation Application

The following local alarm points are provided in the lube oil system for each diesel generator:

a) low oil pressure

b) low oil pressure trip

c) low oil temperature; in/out

d) high oil temperature; in/out

e) high oil temperature trip

f) high differential pressure across filter

g) high differential pressure across strainer

h) low oil level in the sump

i) low turbocharger oil pressure; left/right

j) low turbocharger oil pressure trip

k) auxiliary lube oil pump on

l) high crankcase pressure trip

Operation of any of the alarms is indicated by "trouble" or "trip" alarms in the Control Room.

In addition, the following pressure and temperature switches are provided for tripping the diesel engine unless the diesel generator is operating due to a loss of offsite power or a Safety Injection Signal (SIS).

a) high oil temperature,

b) low oil pressure

c) low turbocharger oil pressure, right or left

d) high crankcase pressure

The following pressure and temperature devices are provided for local indication. Thermocouples are located in the lube oil supply and return piping to allow for remote monitoring of the lube oil inlet and outlet temperatures when operating or in standby.

a) lube oil pressure

b) differential pressure-lube oil filter

c) turbocharger oil pressure; left/right

d) crankcase pressure

e) lube oil sump tank level

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 designed to supply adequate combustion air to the diesel generators and to exhaust the combustion products to the atmosphere. As shown on Figures 1.2.2-86 and 1.2.2-87, the combustion air intakes are arranged in a manner that affords protection from external missiles and high winds. The combustion air intakes and exhausts are designed to withstand safe shutdown earthquake and tornado forces. The system meets minimum safety requirements assuming a single failure.

The diesel generator combustion air intakes and exhausts are shown on Figure 9.5.5-2.

The combustion air intakes are composed of intake screens (bird screens) located on the exterior wall of Diesel Generator Building at Elevation 297 ft. and intake ducts located in the missile protection wall behind the bird screens at Elevation 307 ft. The vertical offset between the bird screens and intake ducts acts to protect the combustion air intakes from external missile damage. The intake ducts vent to a plenum formed by the floor at Elevation 292 ft., the roof at Elevation 312 ft., the vertical walls forming the exhaust silencer enclosure and the vertical diesel generator building walls extending from Elevation 292 ft. to 312 ft. A dry type intake filter and silencer for each diesel generator is installed indoors with intake piping of adequate size to prevent excessive pressure drop. The exhaust piping from each diesel generator exhaust outlet to the exhaust silencer is located above Elevation 279 ft. The exhaust silencer is located at Elevation 292 ft. Exhaust piping from the silencer exits the Diesel Generator Building through a missile protected enclosure above roof Elevation 312 ft. The exhaust piping is of sufficient size to prevent excessive back pressure. The engine is provided with an 8 in. non-safety, non-seismic atmospheric vent to prevent buildup of crankcase pressure. Refer to Figures 1.2-86 and 1.2-87 for equipment location.

Expansion joints for exhaust and intake piping are provided to protect the equipment from forces due to thermal expansion or vibration.

9.5.8.3 Safety Evaluation

The combustion air intake to each diesel generator is designed to Safety Class 3 and Seismic Category I requirements (see Section 3.2), protected from tornado generated missiles, and shielded from direct wind, rain or snow. The systems are designed such that a single active failure in an engine combustion air intake or exhaust system will not lead to the loss of function of more than one diesel generator. These intake and exhaust systems are independent, and they are sized and physically arranged such that no degradation of engine function will be experienced when the diesel generator set is required to operate continuously at the maximum rated power output. The combustion air intake system is provided with filters in order to reduce airborne particulate material over the entire time period that emergency power is required, assuming the maximum airborne particulate concentration at the combustion air intake. The combustion products exhaust system is classified as a Safety Class 3 and Seismic Category I requirements as described in Table 3.2.1-1. The exhaust system piping is fabricated and designed in accordance with ANSI B31.1 and Seismic Category I requirements. A 10 CFR 50 Appendix B QA program has been applied to the exhaust system. The hot gases are exhausted approximately 30 ft. above and 100 ft. laterally from the air intakes, thus avoiding the possibility of recirculation of diesel combustion products.

The air intakes for each diesel generator compartment are located at Elevation 292.00 ft. in the east wall of the diesel generator building. This air is supplied through the combustion air intake filter located on Elevation 292.00 ft. to the diesel generator located on Elevation 261.00 ft. There are two exhaust ducts penetrating the west wall of the diesel generator compartment at about Elevation 280.0 ft. These ducts continue west from this wall to the vicinity of the west wall of the building, turn up at 90° piercing the concrete floors at Elevations 292.00 ft. and 312.00 ft., respectively, to terminate in separate exhaust plena. Each plenum exhausts to atmosphere through an opening located just under the roof at Elevation 327.00 ft. in the west wall of the building.

In the event of a fire in a diesel generator compartment coincident with a single failure of the fire protection system, the hot air and smoke would be exhausted through the openings in the west wall of the diesel generator building air exhaust plena which are at a higher elevation than that of the air intakes located in the east wall of the diesel generator building.

In the event of a fire in the diesel fuel oil day tank room, the heat and smoke from this area will be discharged from one of the plena described above.

Since air intake and exhaust openings are about 105 feet apart at opposite ends of the diesel generator building with hot air and smoke being discharged at an elevation higher than the intake for the cooler air, the combustion air for the remaining diesel will not be degraded by a fire.

Diesel generator exhaust piping is fabricated and tested in accordance with the requirements of ANSI B31.1 and meets all Quality Assurance requirements of Safety Class 3, Seismic Category I piping. The material for the exhaust piping is ASTM A672 GRC-65 Class 10. Intake piping is fabricated and tested in accordance with ASME Section III, Class 3 requirements.

Intake and exhaust system components (silencers, filters, and expansion joints) are manufactured in accordance with the guidelines as stated by the DEMA standards. They are designed in accordance with seismic Category I requirements. The design stresses which

include mechanical, pressure, thermal and seismic induced loads have been determined by the diesel generator manufacturer (i.e., Transamerica DeLaval Incorporated (TDI)) to be well within the allowable stresses as permitted by ANSI B31.1. The TDI approved QA/QC program used in conjunction with the manufacture of diesel engines, engine mounted components, and piping comply with the requirements of Appendix B of 10 CFR 50.

To minimize the amount of concrete dust, the floors, walls, and ceilings in the electrical switchgear (control panels) room of the diesel generator building are sealed for dust control measures. See Section 9.4.5.2.5 for other dust control measures.

The location of chemical storage facilities has been evaluated such that for an accident involving the complete severance of the largest pipe connected to any chemical storage tank, the minimum oxygen concentration (18 percent by volume) required for diesel engine operation would be maintained at the diesel engine combustion air intakes.

Protection against postulated piping failures in high and moderate energy fluid systems is discussed in Section 3.6.

Failure of any non-Seismic Category I structures and components will not affect the safety related performance of the system. The crankcase vent line from the diesel engine is non-safety class and non-seismic. Rupture or breakage of this line will not impede engine capability to start or operate as required. In case the crankcase vent line fails, the vent doors provided on the diesel engine shall open at 0.7 psig without jeopardizing engine performance. The diesel generator room air exhaust rate during engine operation is sufficiently large to prevent the concentration of oil vapors released into the room through the vent doors from reaching combustible limits.

As stated in FSAR Section 2.3.1.2.1 the SHNPP site lies in Region I for Design Basis Tornado. For a Region I Design Basis Tornado the pressure drop is 3.0 psi and the rate of pressure drop is 2.0 psi/sec.

The diesel generator building is designed to withstand the 3 psi pressure drop in 1.5 seconds (rate 2 psi/sec) as a result of tornado. Interior walls are designed for 2 psi differential pressure.

Transamerica-DeLaval, the manufacturer of the Shearon Harris diesel generator, has performed a test and analysis to evaluate the "Dynamic Performance of Enterprise Diesel Engine". The test results indicate no adverse effect on the performance of the diesel generator set due to a pressure drop of 3 psi in 1.5 seconds.

9.5.8.4 Test and Inspection

To ensure the integrity of the diesel engine combustion air intake and exhaust subsystems, scheduled inspection will be performed as part of the overall engine performance check. All filters will be replaced in accordance with manufacturer's recommendation.

The Diesel Generator Combustion Air Intake and Exhaust System instrumentation loops will be checked and the setpoint calibrations will be performed in accordance with the SHNPP Preventive Maintenance Program schedule. Testing of the system will occur with the periodic tests of the emergency diesel generators per Regulatory Guide 1.108.

For compliance with the requirements of Regulatory Guide 1.68 as related to preoperational and start-up testing of the combustion air intake and exhaust subsystems, see Section 1.8.

9.5.8.5 Instrumentation

Local indicators are provided for the following combustion air and exhaust gas parameters:

a) Combustion Air Pressure - Combustion air pressure gauge located on the diesel generator control panel provides the operator with a visible means, without alarm or annunciation, of determining the performance of the turbocharger. No interlock is required.

b) Cylinder Temperature (left bank, right bank) - Cylinder temperatures are determined during the operator's periodic inspection of the operation of the diesel generator. Temperatures for both banks of cylinders are obtained by the operator turning the temperature controlled selector switch, which is mounted on the Diesel Generator Control Panel, to the desired cylinder for temperature investigation. No alarm, annunciation, or interlocks are required.

c) Exhaust Manifold Temperature (left, right) - Exhaust manifold temperatures are determined during the operator's periodic inspection of the diesel generator. Temperatures for the left manifold and right manifold are obtained by the operator turning the temperature controlled selector switch, which is mounted on the Diesel Generator Control Panel, to the desired exhaust manifold for temperature investigation. No alarm, annunciation, or interlocks are required.

The Diesel Generator Combustion Air Intake and Exhaust System instrumentation loops will be checked and the setpoint calibrations will be performed in accordance with the SHNPP Preventive Maintenance Program schedule. Testing of the system will occur with the periodic tests of the emergency diesel generators per Regulatory Guide 1.108. None of the Diesel Generator Combustion Air Intake and Exhaust System instrumentation provide an alarm condition to alert the operator. An out-of-specification valve will present itself as a decrease in engine performance, i.e., less load carrying capability or uneven engine operation (increased vibration) which are monitored or alarmed at the local and remote control panels. These allow operator action to localize the source of the abnormal condition and to prevent damage to the diesel engine.

APPENDIX 9.5A FIRE HAZARDS ANALYSIS

Deleted by Amendment 57

TABLE 9.1.2-1

NEW AND SPENT FUEL RACK DESIGN ATTRIBUTES

POOL	Fuel Type	Storage Array Size (Cells)	Rack Dimensions (Inches)	Licensed Number of Racks	Total Licensed Storage Capacity
A	PWR	6 x 10	62.4 x 104.0	6	360
	BWR	11 x 11	69.0 x 69.0	3	363
B	PWR	6 x 10	62.4 x 104.0	5	300
		7 x 10	72.8 x 104.0	6	420
		6 x 8	62.4 x 83.2	1	48
	BWR	11 x 11	69.0 x 69.0	18	2178
C	PWR	9 x 11	81.5 x 99.5	2	198
		9 x 9	81.5 x 81.5	13	1053
	BWR	13 x 13	81.5 x 81.5	5	845
		11 x 13	69.0 x 81.5	6	858
		8 x 13	50.5 x 81.5	2	208
		8 x 11	50.5 x 69.0	2	176
D	PWR	8 x 10	72.5 x 90.5	6	480
		8 x 11	72.5 x 99.5	2	176
		9 x 10	81.5 x 90.5	3	270
		9 x 11	81.5 x 99.5	1	99
Total[1]				80	8,032

[1] Upon installation of all racks in all four pools.

TABLE 9.1.2-2

HARRIS SPENT FUEL RACK DIMENSIONS *

Pools A and B Rack Design Parameter

	PWR	BWR
C-C SPACING	10.50	6.250
CELL I.D.	8.750	6.050
POISON CAVITY	0.090	0.060-0.080
POISON WIDTH	***	5.100
CELL GAP	1.330	---
POISON THICKNESS	***	0.045-0.075
CELL WALL THICKNESS	0.075	0.075
WRAPPER THICKNESS	0.035	0.035
POISON (^{10}b GM/CM^2)	***	0.0103-0.015

Pools C and D Rack Design Parameter

		PWR	BWR
C-C SPACING:			
	(BORAL)	9.0	6.25
	(METAMIC)	9.017	
CELL I.D.		8.8	6.06
POISON CAVITY:			
	Inner Box (BORAL)	0.107	0.082
	Rack Periphery (BORAL)	0.106	0.110
POISON CAVITY:			
	Inner Box (METAMIC)	0.109 MIN.	N/A
	Rack Periphery (METAMIC)	0.109 MIN.	N/A
POISON WIDTH:			
	Inner Box	7.5	5.0
	Rack Periphery	7.5	3.5
CELL GAP		N/A	---
POISON THICKNESS (BORAL)		0.098	0.075-0.101
POISON THICKNESS (METAMIC)		0.104	N/A
CELL WALL THICKNESS:		0.075	0.075
WRAPPER THICKNESS:**			
	Inner Box	0.035	0.035
	Rack Periphery	0.075	0.075
POISON (^{10}B gm/cm^2) (BORAL)		0.302	0.0162
POISON (^{10}B gm/cm^2) (METAMIC)		0.0304	N/A

* All dimensions are nominal and units are in inches, unless noted otherwise

** Neutron absorbing material is not needed or used on the exterior walls of modules facing non-fueled regions, i.e., the pool walls. However, at least one panel is used between storage racks.

*** Poison is not credited. Poison cavity and wrapper dimensions included in analysis of the spent fuel rack.

TABLE 9.1.3-2 FUEL POOL COOLING AND CLEANUP SYSTEM PARAMETERS

Fuel Pool Heat Load, Equilibrium Temperature and Heat Inertia[1]

Fuel Pool Heat Load (A/B)	
Incore Shuffle	22.17 x 106 Btu/hr
Full Core Offload	40.56 x 106 Btu/hr
Normal Post Outage Full Core Offload (Emergency Core Offload)	46.23 x 106 Btu/hr
Maximum Heat Load During Normal Operations[2]	18.31 x 106 Btu/hr
Fuel Pool Heat Load (C/D)	7.0 x 106 Btu/hr
Fuel Pool Equilibrium Temperature[3]	
Incore Shuffle	≤150°F
Full Core Offload Shuffle	≤150°F
Post Outage Full Core Offload	≤150°F
Combined Spent and New Fuel Heat Pool Heat Inertia	
Normal Operation	4.73°F/hr
Incore Shuffle	5.75°F/hr
Full Core Offload Shuffle	10.56°F/hr
Post Outage Full Core Offload	11.98°F/hr
Fuel Pool Heat Exchanger	
Quantity (per FPCCS)	2
Type	Shell and Two Pass Straight Tube
UA (Design per Heat Exchanger), Btu/hr.-F	21.1×10^5
Shell Side (Component Cooling Water) - Design	
Inlet temperature, F	105
Outlet temperature, F	110
Design flowrate, lb./hr.	2.68×10^6
Design pressure, psig	170
Design temperature, F	200
Material	Carbon Steel

TABLE 9.1.3-2 FUEL POOL COOLING AND CLEANUP SYSTEM PARAMETERS

Tube Side (Fuel Pool Water) - Design	
Inlet temperature, F	120
Outlet temperature, F	113
Design flowrate, lb.	1.88×10^6
Design pressure, psig	150
Design temperature, F	200
Material	Stainless Steel
Fuel Pool Cooling Pump	
Quantity (per FPCCS)	2
Type	Horizontal Centrifugal
Design flowrate, gpm	4560
TDH, ft. H20	98
Motor horsepower	150
Design pressure, psig	150
Design temperature, °F	200
Material	Stainless Steel
New Fuel Pool (Pool A or New Fuel Pool Unit 1)	
Volume, gallons (at normal level, elevation 284.5 feet)	142,272
Boron concentration, ppm (minimum)[4]	2,000
Liner material	Stainless Steel
Spent Fuel Pool (Pool B or Spent Fuel Pool Unit 1 or Pool C)	
Volume, gallons (at normal level, elevation 284.5 feet)	388,800
Boron concentration, ppm (minimum)[4]	2,000
Liner material	Stainless Steel
Spent Fuel Pool (Pool C or Spent Fuel Pool Unit 2)	
Volume, gallons (at normal level, elevation 284.5 feet)	388,800
Boron concentration, ppm (minimum)[4]	2,000
Liner material	Stainless Steel
Spent Fuel Pool (Pool D or Spent Fuel Pool Unit 2)	
Volume, gallons (at normal level, elevation 284.5 feet)	184,307
Boron concentration, ppm (minimum)[4]	2,000
Liner material	Stainless Steel

TABLE 9.1.3-2 FUEL POOL COOLING AND CLEANUP SYSTEM PARAMETERS

Fuel Pool Demineralizer Filter	
Quantity (per FPCCS)	1
Type	Back Flushable
Design pressure, psig	400
Design temperature, °F	200
Flow, gpm	325
Maximum differential pressure across filter element at rated flow (clean filter), psi	5
Maximum differential pressure across filter element prior to backflush, psi unit 1/unit 2	60/15
Fuel Pool Demineralizer	
Quantity (per FPCCS)	1
Type	Flushable
Design pressure, psig	400
Design temperature, F	200
Design flowrate, gpm	325
Volume of resin (each), ft3	85
Fuel Pool and Refueling Water Purification Filter	
Quantity (per FPCCS)	1
Type	Back Flushable
Design pressure, psig	400
Design temperature, F	200
Design flowrate, gpm	325
Maximum differential pressure across filter element at rated flow (clean filter), psi	5
Maximum differential pressure across filter element prior to backflush, psi unit 1/unit 2	60/15
Fuel Pool Strainer (per FPCCS)	
Quantity	1
Type	Basket
Design flowrate, gpm	4560
Design pressure, psig	150
Design temperature, F	200
Maximum differential pressure across the strainer element above flow (clean), psi	1.4

TABLE 9.1.3-2 FUEL POOL COOLING AND CLEANUP SYSTEM PARAMETERS

Mesh	40
Fuel Pool Skimmer Pump Suction Strainer (per FPCCS)	
Quantity	1
Type	Duplex Basket
Design pressure, psig	150
Design temperature, F	200
Design flowrate, gpm	385
Maximum differential pressure across strainer element at rated flow (clean), psi	5
Maximum differential pressure across strainer element prior to removing, psi	60
Mesh	100
Fuel Pool Skimmer Filter (per FPCCS)	
Quantity	1
Type	Back Flushable
Design pressure, psig	400
Design temperature, F	200
Design flowrate, gpm	400
Maximum differential pressure across filter element at rated flow (clean), psi	5
Maximum differential pressure across filter element prior to removing, psi unit 1/unit 2	60/15
Fuel Pool Skimmer Pump	
Quantity (per FPCCS)	1
Design flowrate, gpm	385
TDH, ft. H20	210
Motor horsepower	40
Design pressure, psig	150
Design temperature, F	200
Material	Stainless Steel
Fuel Pool and Refueling Water Purification Pump	
Quantity (per FPCCS)	2
Type	Vertical In-line Centrifugal
Design flowrate, gpm	325
TDH, ft. H20	320

TABLE 9.1.3-2 FUEL POOL COOLING AND CLEANUP SYSTEM PARAMETERS

Motor horsepower	60	
Design pressure, psig	150	
Design temperature, F	200	
Material	Stainless Steel	
Fuel Pool Cooling and Cleanup System Piping and Valves		
Material	Stainless Steel	
Design pressure, psig	150	
Design temperature, F	200	
Fuel Pool Skimmers	Quantity	gpm each
Spent Fuel pool (Pool B and C)	5	35
New Fuel Pool (Pool A and D)	3	30
Fuel Transfer Canal (2 ach canal – south and north)	4	25
Main Fuel Transfer Canal (per FPCCS)	1	20
Cask Loading Pool	1	50

[1] Based on Equilibrium PUR cycle and accumulation in pools A/B of fuel with burnups from PUR. The C/D inventory is based on the license amendment request for 1 x 10^6 Btu/hr of storage.
[2] This heat load is consistent with a refueling outage duration of 15 days or greater.
[3] Administrative controls are placed on the minimum cooling time prior to transfer of irradiated fuel from the core to the storage facility to maintain the pools at less than or equal to 140°F. The minimum decay time prior to movement of irradiated fuel in the reactor vessel will address both radiological and decay heat considerations.
[4] The actual boron concentration will be determined by the plants' Technical Specifications for Refueling.

TABLE 9.1.4-1

FHB AUXILIARY CRANE

a) The crane is designed, fabricated, installed, inspected, tested, and operated in accordance with the requirements of ANSI B30.2, "Safety Standards for Overhead and Gantry Cranes", and CMAA Specification No. 70, "Specifications for Electric Overhead Traveling Cranes", as applicable.

b) Design, fabrication, workmanship, materials, and construction of the crane structure is in accordance with the AISC, "Specification for the Design, Fabrication and Erection of Structural Steel for Buildings" except that permissible unit stresses in welds are as contained in Table 9.3-1 and Paragraph 9.3 of AWS D1.1, "Structural Welding Code", or CMAA Specification No. 70, "Specifications for Electric Overhead Traveling Cranes," whichever is more restrictive.

1) Allowable Stresses and Safety Factors

The following allowable stresses and factors of safety are used unless greater strength requirements are specified in CMAA Specification No. 70 for Class A Cranes. Factors of safety are based on the loading combinations and the ultimate strength of the materials.

a) Hoist rope has a factor of safety of six based on the lead line stress computed from the rated load, modified by a factor representing the efficiency of lifting tackle, but excluding impact load.
b) All parts subject to dynamic strains such as gears, shafts, drums, blocks, and other integral parts have a factor of safety of five.
c) Bending stress combined with torsional stress in pins and axles does not exceed 20 percent of the yield stress of material used.
d) Normal torsional deflection in bridge drive shaft is limited to 0.08 degrees per foot at two thirds of rated motor torque or a total movement at wheel circumference of 1/2 in., whichever is more restrictive.
e) Hook stresses do not exceed 1/5 of the ultimate strength or 1/3 of the yield strength of the material used, whichever is smaller.

2) Design and Loading Conditions

All structural and mechanical parts of the crane are designed to resist dead and live loads, seismic loads and the forces produced by impact and thrust. Fatigue analysis is considered for load bearing components for a usage factor of 20,000 to 100,000 full load cycles.

Table 9.1.4-1 (Continued)

a) The crane structures, components and subsystems essential to retaining and holding the load in a stable or immobile safe position, and means provided for safely moving the crane manually with load and emergency lowering of the load are designed to sustain an SSE event.

   Structures, components and subsystems other than those covered above are designed such that they will not fall off from the crane during a seismic event and the failure of which will not damage the seismically qualified items covered above.

b) Bridge trucks and trolley are provided with restraints to prevent them from leaving their runways with or without the design load during normal operation or under any seismic excursions.

c) The portions of the vertical hoisting system components, which include the head block, rope reeving system, load block and dual load-attaching device are each designed to support a static load of 200 percent of the design rated load, using allowable stresses and safety factors specified above.

d) All parts of the crane are designed to resist any of the following conditions of loading, using allowable stresses and safety factors specified above and those specified herein:

   (1) Dead load plus live load plus impact

   (2) Dead load plus live load, plus the lateral or longitudinal thrust

   (3) Dead load plus live load plus SSE plus pendulum and swinging load effects.

   (4) Rated breakdown torque of motors

   (5) Collision with bumper stops with no load

   For conditions (1), (2), and (5), members are designed in accordance with basic allowable stresses of CMAA Specification No. 70, AISC Code, or AWS D1.1, whichever governs.

   For condition (3), members are designed for 1.6 times the allowable stresses. Local overstressing is permitted for condition (3) provided it can be demonstrated that the crane retains the design load and does not fall from the runway. Ability of the crane for emergency manual transferring and lowering of the load is maintained after the seismic event.

Table 9.1.4-1 (Continued)

For condition (4) stresses do not exceed 90 percent of the elastic limit of the material.

c) During the construction phase of the project the use of the crane shall be controlled to assure that the lift capacity and other operating limitations are not exceeded as required in the applicable specifications. Following completion of the construction use and prior to movement of spent fuel in the fuel handling building, the crane shall be refurbished, tested and inspected in accordance with applicable specifications to assure compliance with performance requirements.

d) Minimum operating temperature of the crane is 50 F.

e) All ferritic material which is used in load bearing structural members is impact-tested to determine fracture toughness of the material. Load bearing structural members are defined as structural members stressed in the process of transferring hook loads (vertical or horizontal) through the crane to the main runway. ASTM A-514 material is not used in any load bearing structural members; other low alloy steel may be used with CP&L's (or it's agent's) written approval.

Either drop weight test per ASTM E-208 or Charpy tests per ASTM A-370 may be used for impact testing. The minimum operating temperature, as obtained by following procedures in Subarticle NC-2300 or ND-2300 of ASME B&PV code, Section III, Div. 1, based on the drop weight test or the Charpy V notch impact test respectively, are not higher than 50 F.

f) Welding is performed by using welding procedures, welders, welding operators, and tackers qualified in accordance with AWS D1.1.

g) Postweld heat treatment of welded assemblies is performed, if necessary, when an assembly is under restraint during welding, when machining is to be performed, or for welded steel greater than 1-1/2 in. in thickness at the welded joint. Welds on all load bearing structural members are Postweld heat-treated in accordance with Subarticle NF-4620 of ASME B&PV Code, Section III, Div. 1, or other requirements as approved by CP&L (or its agent).

h) Where practical, weld joint designs susceptible to laminar tearing are not used. Weld joints susceptible to laminar tearing are ultrasonically tested for soundness of base metal and weld metal of the completed weld joint.

   i) Full penetration butt welds on all load-bearing structural members are 100 percent radiographed for soundness of weld metal and base metal where accessible. Full penetration tee welds on all load-bearing structural members and full penetration butt welds on all load-bearing structural members which cannot be radiographed are tested as follows:

Table 9.1.4-1 (Continued)

1) Magnetic particle or liquid penetrant test of root pass and final weld layer.

2) Ultrasonic test of completed weld joint for soundness of weld metal and base metal.

All fillet welds and partial-penetration welds are visually inspected in accordance with and to the acceptance criteria of AWS D1.1 Paragraph 9.25. Fillet welds and partial-penetration welds joining load-bearing structural members are inspected by liquid penetrant or magnetic particle methods after the final weld layer is applied.

j) The automatic and manual controls for all motions are designed such that a malfunction in the control system will not prevent the load from being maintained at a safe, holding position.

k) The hoisting system is designed to provide two completely independent load paths such that the failure of any single component in either load path system will result in the other assuming the full load and retaining it in a safe, stable position.

The following basic load path components are provided with redundant counterparts or otherwise protected against subsystem or component failure:

1) Hook

2) Load block

3) Reeving

4) Head block

5) Drum

6) Braking system

7) Gear train

Hoist cable redundancy is achieved by the provision of two balanced reeving systems consisting of two separate load-sharing wire ropes reeved in such a manner that the breakage of one rope will result in its share of the load being immediately transferred, without development of slack, to the other. The centers of lift of the two independent cable systems are coincident so as to minimize the swinging or twisting motion imparted to the load block when load transfer occurs following a cable break.

Each load path is designed to resist the full load as specified in Paragraph b) 2).

An equalizer system of the beam type is provided whose main functions are as follows:

Table 9.1.4-1 (Continued)

1) Continually adjust the hook load during normal hoisting operations so that the load will be shared equally by all parts of the reeving system.

2) Transfer the shock of a cable break in a safe dynamic fashion to the remaining cable by means of a shock absorbing arrangement permitting load transfer from one side of the equalizer system to the other without the imparting of unacceptably large dynamic impact to the cable or crane.

The equalizer system is provided with a set of proximity limit switches actuated by an exaggerated displacement of the equalizer assembly such as would be experienced in the event of a cable break. Limit switches so actuated will set the holding brakes to stop and retain the load in a safe, stable position.

The equalizer assembly is attached to the trolley frame by means of a redundant system of supports.

Following the failure of a component or subsystem, means are provided to safely move and lower the load to a laydown area to allow the failed component(s) or subsystem(s) to be repaired, adjusted or replaced as required to return the crane to service.

An electronic load indicating device is provided to monitor both load paths and will set the holding brakes in the event of a cable break or rope load unbalance.

1) Dual load attaching points of redundant design are provided as part of the load block assembly for the support of the redundant subcomponents of the hook. Each hook subcomponent and attaching point is capable of supporting three times the rated load, statically applied, without permanent deformation of any part of the hook and load block assembly other than that due to localized stress concentrations in areas where additional material has been provided for wear.

   A 200 percent static load test is performed on each redundant subcomponent of the hook. Measurements of the geometric configurations are made before and after the load test. Nondestructive examination is performed before and after the load test, consisting of magnetic particle and ultrasonic testing in accordance with the following:

   a) The hook forging is ultrasonically examined in accordance with ASTM A-388. The results of the ultrasonic examination are analyzed and documented.

Table 9.1.4-1 (Continued)

b) Hook shank and load areas are magnetic-particle examined by the longitudinal method in accordance with ASTM E-109, Appendix A1, Paragraph A1.2.1.3. Other magnetic particle examination methods may be used provided care is taken to prevent local overheating, burning or arcing of the surface to be tested. All cracks are unacceptable and all linear indications or aligned porosity exceeding 1/4 in. in length are unacceptable. All repairs require approval of CP&L (or its agent).

The load block is nondestructively examined by surface and volumetric techniques.

l) Crane motions have the following maximum speeds with full rated load:

1) Hoist: 5 fpm

2) Bridge Travel: 100 fpm

3) Trolley Travel: 50 fpm

Slow speeds for precise handling and setting are provided by inching drives at five percent of the full rated speed for bridge and trolley travel and between 6 to 12 in. per minute for the hoist.

m) The maximum fleet angle does not exceed 3-1/2 degrees at any point during hoisting, except that for the last three ft. of maximum lift elevation, the fleet angle may increase slightly.

Use of reverse bends for running wire ropes are limited so that disproportionate reduction in wire rope fatigue life would not be expected.

Pitch diameter is at least 24 times the diameter of rope for the drums and sheaves, and at least 12 times the diameter of rope for equalizer sheaves. (Ropes are stainless cable ASTM A-492, type 304 with independent wire rope core having six strands of 37 wires per strand.)

n) A limit switch activated by the hook block and a gear type limit switch are provided to prevent the hoisting system from "two blocking".

o) An overload protection device of redundant design is provided for the hoisting system which will be actuated by a load in excess of 110 percent of the hook rating, thereupon opening the main hoist circuit and setting the holding brakes.

Table 9.1.4-1 (Continued)

p) Brakes are as follows:

1) Bridge Travel: Electrically released, spring-set, friction-shoe type with capacity at least equal to full operating torque of the bridge drive. Break will operate when motor controller is in OFF position, when main power supply switch is in OFF position, or in the event of power failure, or an overspeed or overload condition.

2) Trolley Travel: Electrically released, spring-set, friction-shoe type brake with capacity at least equal to full operating torque of the trolley drive. Brake will operate when motor controller is in OFF position, when main power supply switch is in OFF position, or in the event of a power failure, or an overspeed or overload condition.

3) Bridge and trolley braking systems are designed to be Single Failure Proof and capable of manual operation for emergency service.

4) Hoist: Two electric stopping and holding brakes, and one electrical hoist-control device as further specified in sub-paragraphs (a) and (b) following:

a) Electric stopping and holding brake for the hoist operates automatically and is of the electrically released, spring-set, friction-shoe type capable of stopping and holding 1-1/2 times the full rated load when the power is off. Brakes are mounted on the motor shafts extending from opposite sides of the motor. When the power is off, or tripped by overspeed or overload devices, or activated by one of the limit switches described elsewhere, the brake is capable of stopping and holding the load.

b) Electrical hoist control devices are of the eddy current type. They are capable of controlling the lowering speed under all conditions with up to 1-1/2 times the rated load on hook. No lowering of load occurs unless power is applied to hoist motor in a lowering direction.

5) Two hoist holding brakes are capable of operation for emergency lowering after a single failure. Provisions are made for manual operation of the holding brakes in this event by means of alternate lowering and holding to provide time for adequate heat dissipation. Design for manual brake operation during emergency lowering includes features to indicate and control the lowering speed.

q) The drum is provided with structural and mechanical devices to prevent it from dropping, rotating or disengaging from its holding brake system should failure occur in the drum shaft, bearing, or bearing support.

The hoist drum is provided with an overspeed switch which will cut power to the hoist and set the holding brakes should the drum attain 40 percent overspeed.

Table 9.1.4-1 (Continued)

r) Design of the crane limits the torque during jogging and plugging to acceptable values.

s) Drift point in the electrical power system for bridge or trolley movement is provided only for the lowest operating speeds.

t) The crane is radio controlled for remote operation. The crane can also be pendant controlled from the operating floor. The pushbutton pendant control is suspended from the bridge and supported from a motorized messenger track so that the pendant can be placed at any position along the length of the bridge. The pushbuttons are spring loaded to ensure automatic return to "OFF" position when buttons are released. The pendant control cable is mounted to an electric hoist system to enable the operator to vary the height of the control.

An additional control station, mounted on the building wall near the storage position of the crane, is provided to control the movements of the crane bridge and the pendant station in an area within 50 ft. from the storage position of the crane. Once the pendant station takes control of the crane, the wall station will be inoperative until the main switch on the pendant is switched to the OFF position.

Purpose of the wall-mounted station is to bring the crane in and out of the storage position only. Handling of loads is not controlled by the wall-mounted station.

u) The bridge and trolley are provided with accessible enclosed limit switches, which, when the bridge or trolley has traveled to within nine in. of its end stop, will interrupt the current to the drive motor. Reversing the motion of the bridge or trolley will reset the switch. A bypass control is provided to allow the bridge or trolley to approach end stops.

Also provided are two independent methods to prevent Auxiliary Crane from coming in contact with the Cask Crane as described in Section 9.1.4.2.2.7.

v) A capacity plate showing both design rated load capacity (12 ton) and maximum working load capacity (10-ton) of the hoist is placed on each crane girder and is easily legible from the operating deck.

w) Instruction manuals are provided by the manufacturer for each component covering installation, operation and maintenance instructions in accordance with Ebasco Instruction Manual Guidelines, General Instructions (Form 567-A), Mechanical Equipment Including Major Heating, Ventilating and Air Conditioning Equipment (Form 567-C) and Electrical Equipment (Form 567-E).

Instruction manual also includes the following:

1) Qualification requirements for crane operators

2) Procedure for emergency manual operations for moving the crane and lowering the load, and locations of manual controls

Table 9.1.4-1 (Continued)

3) Field test procedures

Maintenance instructions are based on maintaining the crane at design rated load capacity.

x) The manufacturer is required to provide a competent, experienced representative, on completion of crane installation, to check and certify that the crane has been properly erected; instruct CP&L in the crane operation, lubrication, and periodic maintenance adjustments; and also direct CP&L in the initial crane operation to demonstrate its satisfactory performance for acceptance by CP&L.

The crane system is static load tested at 125 percent of the design rated load. The test includes all positions generating maximum strain in the bridge and trolley structures and other positions as recommended by the manufacturer. After satisfactory completion of the 125 percent static test and adjustments required as a result of the test, the crane is full performance tested with 100 percent of the design rated load for all speeds and motions for which the system is designed. This will include verifying all limiting and safety control devices.

The features provided for manual lowering of the load and manual movement of the bridge and trolley during an emergency are tested with the maximum working load attached to demonstrate their ability to function as intended.

The protective overload devices are tested to ensure proper functioning of the devices by a test procedure recommended by the manufacturer.

Above tests are run within temperature range as specified for the plant operation phase.

y) The crane manufacturer has an accepted quality assurance program consistent with the pertinent provisions of Appendix B to 10 CFR Part 50.

TABLE 9.2.1-1 SERVICE WATER REQUIREMENTS (gpm)

	Normal Operation [1]				Emergency Operation [2]				
					Post LOCA – Single Loop		Post LOCA – Full Flow		
	Startup	Normal Operation	Shutdown[3] at 4 Hours	Hot Standby	Injection	Recirculation	Injection	Recirculation	Loss of Off-Site Power Hot Standby Single Loop Flow
Component Cooling Water Heat Exchanger	10,000	10,000	20,000	10,000	8,500	8,500	17,000	17,000	8,500
Reactor Auxiliary Building HVAC Chillers	2,000	2,000	4,000	2,000	2,000	2,000	4,000	4,000	2,000
Standby Diesel Generator Coolers	800	800	1600	800	800	800	1,600	1,600	800
Emergency Supply to Steam Generator Auxiliary Feed Pumps[9]	--	--	--	--	[11]	[11]	[11]	[11]	[11]
Boron Thermal Regeneration (CVCS) Chillers	414	414	414	414	--	--	--	--	--
Charging Pump II Coolers[8]	40	40	60	40	40	40	60	60	40
SSE Fire Protection	--	--	--	--	[12]	[12]	[12]	[12]	[12]
Makeup to RAB Evaporator Air Coolers	10	10	10	10	--	--	--	--	--
Containment Fan Coolers[10]	2,600	2,600	5,200	2,600	2,600	2,600	5,200	5,200	2,600
Containment Fan Coil Units (NNS)	2,400	2,400	2,400	2,400	-	-	-	-	-
Waste Processing Building Cooling Water Heat Exchanger	10,000	10,000	10,000	10,000	-	-	-	-	-
Waste Processing Building HVAC Chiller	5,200	5,200	5,200	5,200	-	-	-	-	-
Makeup to WPB Evaporative Air Coolers	12	12	12	12	-	-	-	-	-
Turbine Building Auxiliaries	10,515	10,515	813[5]	10,515[5]	-	-	-	-	-
Plant Sampling System (Post-Accident Sampling System Chiller)	87	87	87	87	150	150	150	150	150
Emergency Service Water Intake Screen Wash Pump	-	-	-	-	270	270	540	540	270
Emergency Service Water Strainer Back Wash	-	-	-	-	650	650	1,300	1,300	650
Normal Service Water Strainer Back Wash	2,000	2,000	2,000	2,000	-	-	-	-	-

TABLE 9.2.1-1 SERVICE WATER REQUIREMENTS (gpm)

	Normal Operation (1)				Emergency Operation (2)				
					Post LOCA – Single Loop		Post LOCA – Full Flow		Loss of Off-Site Power Hot Standby Single Loop Flow
	Startup	Normal Operation	Shutdown(3) at 4 Hours	Hot Standby	Injection	Recirculation	Injection	Recirculation	
Emergency Service Water and Cooling Tower Makeup Water Intake Structure Air Coolers(7)	-	-	-	-	-	-	-	-	-
Radiation Monitor Coolers	175	175	175	175	-	-	-	-	-
Secondary Sample System	240	240	240	-	-	-	-	-	-
Circulating & Service Water Chlorination System	-	-	-	-	-	-	-	-	-
Total Required Flow(4)(6)	46,495	46,495	52,213	46,495	15,010	15,010	30,390	30,390	15,010
Rated Pump Capacity	50,000	50,000	50,000	50.000	21,500	21,500	43,000	43,000	21,500
Number of Pumps Required	1	1	1	1	1	1	2	2	1

NOTES:

(1) Utilizes Normal Service Water Pumps
(2) Utilizes Emergency Service Water Pumps
(3) This is for accelerated cooldown - however, reactor can be cooled with only one Component Cooling Water Heat Exchanger.
(4) Normal Service Water pump capacity is based on preliminary equipment cooling water requirements.
(5) Turbine Generator heat loads are negligible by the time RHR is placed in service (SW-0043).
(6) Total ESW flow is the sum of calculated individual requirements based on the most limiting conditions for each particular component. Refer to Calc SW-0080 for measured (flow balance) flow requirements for the ESWS.
(7) The ESW requirement to the Intake Structure Air Coolers is based on an evaluation which permits isolation of ESW.
(8 Each CSIP receives 20 gpm. In the single train cases, the spare CSIP is assumed to be receiving flow from the inservice header. For the two train cases, all three CSIP's receive flow for a total for 60 gpm.
(9) ESW is the backup source of water in the event of loss of Condensate.
(10) The flow rate of 2600 (1300 per train) was used in containment analysis calculation HNP-M/MECH-1008 and is based on one coil (16 tubes) per train being plugged.
(11) ESW has the capability to supply AFW suction 374 gpm.
(12) ESW has the capability to supply SSE Fire Protection up to 150 gpm.

TABLE 9.2.1-2

SERVICE WATER SYSTEM COMPONENT DATA

Normal Service Water Pumps	
Quantity	2
Type	Vertical Centrifugal
Driver	Motor
Design Flow, gpm	50,000
Design Head, ft.	185
Fluid Pumped	Cooling Tower Circulating Water
Seismic Category	Non-Seismic Category I
Design Pressure, psig	150
Design Temperature, F	140
Material	Carbon Steel
Emergency Service Water Pumps	
Quantity	2
Type	Vertical Centrifugal
Driver	Motor
Design Flow, gpm	20,000
Design Head, ft	.225
Fluid Pumped	Lake Water
Seismic Category	I
Design Pressure, psig	156
Design Temperature, F	140
Material	Carbon Steel
Code	ASME Section III, Code Class 3
Service Water Booster Pumps	
Quantity	2
Type	Horizontal Centrifugal
Driver	Motor
Design Flow, gpm	4250
Design Head, ft.	120
Fluid Pumped	Lake Water
Seismic Category	I
Design Pressure, psig	225
Design Temperature, F	140
Material	Carbon Steel
Code	ASME Section III, Code Class 3
Piping and Valves	
a) Nuclear Safety Class Code	ASME Section III, Code Classes 2 and 3
b) Non-nuclear Safety Class Code	ANSI B31.1
Self-Cleaning Strainers	
Quantity	2
Mounting	Horizontal
Design Flow, gpm	21,500
Fluid	Lake Water
Seismic Category	I
Design Pressure, psig	150
Design Temperature F	140
Material	Carbon Steel
Code	ASME Section III Class 3

TABLE 9.2.1-4

MAXIMUM SERVICE WATER SYSTEM HEAT LOADS FOLLOWING SAFE SHUTDOWN

Shutdown at 4 hours (RHR system actuated, two trains in operation)

Heat Loads to Service Water System

Component Cooling Water Heat Exchanger	237.5×10^6 Btu/hr.
Containment Fan Cooler	10.72×10^6 Btu/hr.
Reactor Auxiliary Building HVAC Chiller	19.02×10^6 Btu/hr.
Diesel Generator (Two Running)	27.4×10^6 Btu/hr.
Total heat load of Service Water System	294.64×10^6 Btu/hr.

TABLE 9.2.1-5

STATION AUXILIARY HEAT REJECTED TO PLANT COOLING WATER SYSTEM FOLLOWING A SAFE SHUTDOWN

	Integrated Heat Rejected Following Safe Shutdown (Btu)	
	0 - 4 hours	4 - 23 hours
Component Cooling Heat Exchanger (includes the RH RHX heat load)	168.3×10^6	2.590×10^9
Containment Fan Coolers (4 fans operating)	42.9×10^6	$.247 \times 10^9$
Reactor Auxiliary Building HVAC Chiller (2 chillers operating)	76.1×10^6	$.437 \times 10^9$
Standby Diesel Generators	109.6×10^6	$.630 \times 10^9$
Total	396.9×10^6	3.904×10^9

Notes:

(1) The heat loads were integrated to 23 hours because that is approximately the point at which the RCS reaches 140°F, which is the end of the cooldown.

TABLE 9.2.1-6

SERVICE WATER SAFETY CLASS HEAT EXCHANGERS
DESIGN OPERATING TEMPERATURES

Equipment	Number Installed	Design Flow Rate Each Component GPM	Service Water Inlet Temperature	Service Water Outlet Temperature
Containment Fan Coolers	4	1,300	95	98 (181 F, Post LOCA)
Reactor Auxiliary Building HVAC Chillers	2	2,000	95	104.79
Charging Pump Oil Coolers	3	9	95	100
Charging Pump Gear Coolers	3	6	95	100
Standby Diesel Generators	2	800	95	130
Emergency Service Water and Cooling Tower Makeup Water Intake Structure Air Coolers(2)	2	0	0	0
Radiation Monitor Coolers	5	25/50	95	120

(1) Deleted by Amendment No. 51

(2) The ESW requirement to the intake structure air coolers is based on an evaluation which permits isolation of ESW.

TABLE 9.2.1-7

SENSIBLE AND DECAY HEAT REJECTED TO PLANT COOLING WATER SYSTEM FROM REACTOR COOLANT SYSTEM FOLLOWING SAFE SHUTDOWN (OFFSITE POWER NOT AVAILABLE)

Time (hours)	RCS Temp (Deg F)	Total Sensible & Decay Heat (MBTU/HR)	Decay Heat (MBTU/HR)	Sensible Heat (MBTU/HR)	Integrated Decay & Sensible Heat (MBTU)
4	350.00	166.5	102.1	64.40	166.5
5	300.00	160.4	95.70	64.70	326.9
6	250.00	155.4	90.90	64.50	482.3
7	200.00	149.4	87.00	62.40	631.7
8	169.40	104.2	83.80	20.40	735.9
9	158.80	88.8	81.10	7.70	824.7
10	154.50	82.6	78.80	3.80	907.3
11	152.10	79.2	76.70	2.50	986.5
12	150.50	76.8	74.90	1.90	1063.3
13	149.20	74.8	73.30	1.50	1138.1
14	148.10	73.2	71.90	1.30	1211.3
15	147.10	71.8	70.60	1.20	1283.1
16	146.20	70.6	69.40	1.20	1353.7
17	145.30	69.4	68.40	1.00	1423.1
18	144.60	68.4	67.40	1.00	1491.5
19	143.80	67.4	66.40	1.00	1558.9
20	143.20	66.4	65.40	1.00	1625.3
21	142.50	65.4	64.50	0.90	1690.7
22	141.80	64.4	63.50	0.90	1755.1
23	141.10	63.4	62.60	0.80	1818.5
24	140.50	62.6	61.80	0.80	1881.1
24.8	140.00	62	61.20	0.80	1943.1

TABLE 9.2.1-10

STATION AUXILIARY HEAT REJECTED TO PLANT COOLING WATER SYSTEM FOLLOWING SAFE SHUTDOWN

	REJECTION RATE (Btu/hr.)		
Component	0-4 hours[(1)]	4-29 hours[(1)]	29 hours[(1)]
Containment Fan Coolers	10.72×10^{6}[(2)]	10.72×10^{6}	10.72×10^{6}
Reactor Auxiliary Building HVAC Chiller Units	19.02×10^{6}	19.02×10^{6}	19.02×10^{6}
Diesel Generator	27.4×10^{6}	27.4×10^{6}	27.4×10^{6}
Emergency SW Fan Cooler Units[(4)]	0	0	0
Charging Units	0.225×10^{6}	0.225×10^{6}	0.225×10^{6}

	INTEGRATED HEAT REJECTED (Btu/Hr.)		
Component	0-4 hours	4-29 hours	29 hours[(3)]
Containment Fan Coolers	42.9×10^{6}	26.8×10^{7}	29.4×10^{9}

	INTEGRATED HEAT REJECTION (Btu)		
Component	0-4 hours[(1)]	4-29 hours[(1)]	29 hours[(1)]
Reactor Auxiliary HVAC Chillers	76.1×10^{6}	47.6×10^{7}	52.3×10^{9}
Diesel Generator	109.6×10^{6}	68.5×10^{7}	75.3×10^{9}

NOTES:

(1) Average Heat Rate for the time period

(2) Assumes Temperature Inside Containment Remains Constant During Shutdown

(3) Integrated with t = 2778 hours

(4) Cooling Water Isolated

TABLE 9.2.1-11

DECAY AND SENSIBLE HEAT RATE AND INTEGRATED HEAT REJECTED TO PLANT COOLING WATER SYSTEM FOLLOWING LOCA

	CONTAINMENT FAN COOLERS		RHR EXCHANGER		TOTAL	
Time(Sec.)	Heat Rejection Rate (Btu/hr.)	Integrated Heat Rejected (Btu)	Heat Rejection Rate (Btu/hr.)	Integrated Heat Rejected(Btu)	Heat Rejection Rate (Btu/hr.)	Integrated Heat Rejected (Btu)
30	0	0	0	0	0	0
50	0	0	0	0	0	0
100	0	0	0	0	0	0
115	199700000	0	0	0	199700000	0
200	196100000	4672639	0	0	196100000	4672639
300	192400000	10068472	0	0	192400000	10068472
400	190200000	15382361	0	0	190200000	15382361
500	188900000	20647639	0	0	188900000	20647639
800	186600000	36293472	0	0	186600000	36293472
1200	178200000	56560139	253672628	0	431872628	56560139
3600	157100000	168326806	247369232	167013953	404469232	335340759
6000	116900000	259660139	211958978	320123357	328858978	579783496
10000	98940000	379571250	172047673	533460385	270987673	913031635
18000	73040000	570660139	139109630	879190721	212149630	1449850860
40000	61120000	980593472	116619676	1660585823	177739676	2641179295
50000	58630000	1146912917	113255038	1979856259	171885038	3126769176
70000	53930000	1459579583	106879933	2591342287	160809933	4050921870
80000	51570000	1606107361	103692380	2883803832	155262380	4489911193
86400	50070000	1696454028	101744431	3066414331	151814431	4762868359
100000	46870000	1879562917	97494361	3442754272	144364361	5322317189
200000	38560000	3066090694	82619116	5944330349	121179116	9010421043
400000	37710000	5184701806	81202426	10494928751	118912426	15679630557
600000	33280000	7156646250	73056459	14779897779	106336459	21936544029
800000	28620000	8876090694	64379233	18597555869	92999233	27473646564
1000000	24160000	10342201806	56056179	21942983960	80216179	32285185765
5000000	22940000	36508868472	53754058	82948670765	76694058	119457539238
10000000	21590000	67432479583	51274850	155885412085	72864850	223317891668

TABLE 9.2.1-12

STATION AUXILIARY MAXIMUM HEAT REJECTED TO PLANT COOLING WATER SYSTEM FOLLOWING A LOCA[1]

	Safety Injection Phase (t = 0 to 20 min.)		Recirculation Phase (t = 20 min to 2778 hrs.)	
Post-LOCA Fixed Heat Loads, Max. Safeguards Case	Heat Rejection Rate (Btu/hr)	Integrated Het Rejected (Btu)	Heat Rejection Rate (Btu/hr)	Integrated Heat Rejected (Btu)
Spent Fuel Pool	27.00×10^6	13.5×10^6	27.00×10^6	75.0×10^9
Emergency Diesels	27.40×10^6	13.7×10^6	27.40×10^6	76.1×10^9
Reactor Auxiliary Building HVAC Chiller	19.02×10^6	9.5×10^6	19.02×10^6	52.8×10^9
Miscellaneous Component Cooling Water Auxiliary Loads:	$.58 \times 10^6$	$.29 \times 10^6$	$.58 \times 10^6$	16.1×10^9
(RHR Pump Seal Coolers Charging Pump Oil Coolers Post-Accident Sample Chillers)				
TOTALS	**74×10^6**	**37×10^6**	**74×10^6**	**220×10^9**

Post-LOCA Variable Heat Loads, Max. Safeguards Case	Heat Rejection Rate (Btu/hr) Integrated Heat Rejected (Btu)	Post-LOCA Variable Heat Loads, Max. Safeguards Case	Heat Rejection Rate (Btu/hr) Integrated Heat Rejected (Btu)	Post-LOCA Variable Heat Loads, Max. Safeguards Case
RHR Heat Exchangers	0	0	253.7×10^6	155.9×10^9
Containment Fan Coolers	199.7×10^6	56.6×10^6	178.2×10^6	67.4×10^9
TOTALS	**274×10^6**	**94×10^6**	**506×10^6**	**443×10^9**

Note:
(1) This table shows the heat loads used to evaluate the Ultimate Heat Sink.

TABLE 9.2.1-13

SINGLE FAILURE ANALYSIS - SERVICE WATER SYSTEM

Component	Malfunctions	Comments
1)Active Failure		
a) Emergency service water pump	Fails to start	Two pumps are provided, one per loop. Essential cooling water requirements at 95°F can be met by one pump on one loop.
b) Service water booster pump	Fails	Two are provided, one for each loop.
c) Non-essential header(s) isolation valve	Fails to close	Two provided in series.
d) One emergency electric power train	Fails	Redundant trains are provided.
e) Discharge valve to Aux Reservoir	Fails Closed	Redundant trains are provided.
f) Feeder breaker to MCC 1B35-SB	Fails Open	Return headers to the Aux. Reservoir are cross-tied resulting in reduced flow through both trains of ESW. Redundant train remains capable of providing 100% cooling capacity.
Additional analysis provided in EMDRAC 1364-97477.		
2) Passive Failure		
a) Essential loop piping, heat exchangers, or valve body	Rupture or major leakage	Redundant, independent essential loops are provided. Either loop would provide adequate cooling water at 95°F with one operating.
b) Emergency service water pump casing or shaft	Failure	Same as 1) a)
c) Service water booster pump casing or shaft	Failure	Same as 1) b)
d) Emergency service water suction or discharge piping	Rupture or major leakage	Same as 2) a)
e) Electric cable (worst case for a complete train)	Fails	Same as 1) d)
f) Traveling screen	Failure of blockage	Redundant, independent emergency service water pumping loops are provided each with its own traveling screen and screen wash pump.
g) Emergency service water screen wash pumps	Failure	Same as 2) f)

TABLE 9.2.1-14

LEAKAGE ANALYSIS OF SERVICE WATER SYSTEM

Leak Location	Primary Detection Signal	Secondary Concurrent Detection Signals	Method of Leak Isolation
SWS inlet to Component Cooling Water (CCW) Heat Exchanger	Low SWS flow to CCW Heat Exchanger	High temperature in CCW Low flow to all other equipment on loop (except Turbine and Waste Processing Building) High temperature at all equipment on loop (except Turbine and Waste Processing Building)	Shutdown operating loop-switch to other loop
SWS outlet from Containment Fan Cooler (Outside Containment)	High SWS flow from Fan Cooler	Low flow to all equipment on loop (except Turbine and Waste Processing Buildings)	Shut motor operated valve in SW inlet line to Fan Cooler
SWS outlet from Reactor Auxiliary Building	High SWS flow to Chiller	Low flow to Boron Thermal Regeneration Chillers, Emergency Diesels and CCW Heat Exchanger High temperature at above listed equipment	Shut valve in line to chiller
Junction of lines 3SW30-10SA-1 and 3SW30-11SB-1	Low flow in the Reactor Auxiliary Building supply header	Low pressure at normal service water pump discharge	Shut motor operated valves 3SW-B55A and 3SW-B6SB, shut normal service water pumps and initiate plant shutdown using the emergency service water pump

TABLE 9.2.2-1

COMPONENT COOLING SYSTEM DESIGN PARAMETERS

GENERAL		
Service water supply temperature, F	95	
Component cooling water maximum temperature, F		
Normal	105	
Refueling	109	
Cooldown	125	
COMPONENT COOLING SURGE TANK		
Number	1	
Design pressure, psig		
Internal	100	
External	ATM.	
Design temperature, F	200	
Total volume, gallons	2000	
Normal water volume, gallons	1000	
COMPONENT COOLING HEAT EXCHANGER		
Number	2	
Design heat transfer Btu/hr	50.5×10^6	
	Shell	Tube
Design pressure, psig	170	170
Design temperature, F	200	200
Design flow rate, lb./hr.	4.57×10^6	6×10^6
Operating inlet temperature, F	115.8	95
Operating outlet temperature, F	104.9	103.4
Fluid circulated	Component cooling water	Service water
COMPONENT COOLING WATER PUMP		
Type	Horizontal/centrifugal	
Number	3	
Design pressure, psig	225	
Design temperature, F	200	
Design flow rate, gallons per minute	12600	
Minimum developed head at design flow, ft.	169	
COMPONENT COOLING DRAIN TANK		
Number	1	
Design Temperature, F	150	
Design Pressure, psig	ATM	
Total Volume, gallons	300	
Material of Construction	Carbon Steel	

TABLE 9.2.2-3

TYPICAL SYSTEM FLOW RATES DURING NORMAL OPERATION

Component Cooling Water Main Headers	
Total CCW Flow	8295 gpm
RHR HX A OUT FLOW	41 gpm(1)
RHR HX B OUT FLOW	41 gpm(1)
Component Cooling Water to Reactor Coolant Drain Tank HX & Excess Letdown HX	
CCW Flow - Reactor Coolant Drain Tank HX	345 gpm
CCW Flow - Excess Letdown HX	353 gpm
Component Cooling Water to Reactor Coolant Pumps	
CCW Flow - Reactor Coolant Pumps A, B, C Thermal Barrier (each)	57 gpm
CCW Flow - Reactor Coolant Pumps A, B, C Lower Oil Cooler (each)	7 gpm
CCW Flow - Reactor Coolant Pumps A, B, C Upper Oil Cooler Flow (each)	214 gpm
Component Cooling Water to Gross Failed Fuel System and Primary Sample Panel	
CCW Flow - Gross Failed Fuel Detector	15 gpm
CCW Flow - Primary Sample Panel Heat Exchangers	170 gpm
Component Cooling Water to Seal Water HX, Letdown HX, and Recycle Evaporator Package	
CCW Flow - Seal Water HX	334 gpm
CCW Flow - Letdown HX	1176 gpm
CCW Flow - Recycle Evaporator Package	0 gpm(2)
Component Cooling Water to Fuel Pool HXs	
CCW Flow – Fuel Pool Hx (Total for A/B, C/D)	4958 gpm (3)
Component Cooling Water to RHR Pump Coolers	
CCW Flow – RHR A&B Train (each)	9 gpm

Notes:

1) The other component flows are reduced if the RHR HX is in service in that train.

2) The Recycle evaporator package is isolated pending abandonment.

3) These flow values are consistent with the normal system flow rates given in the rest of the table, and they exceed the minimum required to keep the temperature of the Spent Fuel Pools below 150°F. The flow split is dependent on the heat loads in the respective spent fuel pools.

4) The flows shown in this table are from the CCW flow scenario prediction where excess letdown and normal letdown are in service and RHR is out of service.

TABLE 9.2.2-4 FAILURE MODE AND EFFECTS ANALYSIS - COMPONENT COOLING WATER SYSTEM ACTIVE COMPONENTS - SAFE SHUTDOWN AND POST-ACCIDENT OPERATION

Component	Failure Mode	*Effect on System Operation	**Failure Detection Mode	*Remarks
1. Component Cooling Water Pump #1 (Pump #2 analogous)	a. Fails to deliver working fluid.	a. Failure results in a loss of component cooling water to RHR heat exchanger #1. Fault reduces the redundancy of the available RHR coolant trains provided to cool RC flow during the recirculation phase of ECCS operation following an accident. No effect on safety for system operation. Safe shutdown or ECCS cooling requirements will be met by CCW pump #2 delivering component cooling water to RHR heat exchanger #2 for cooling of RC flow.	a. Pump circuit breaker position status lights at MCB; pump circuit breaker position group monitoring light at MCB; pump circuit breaker position annunciator (pump ready to start) at MCB; CCW pump #1 discharge header pressure indication (PI-649) and low pressure alarm at MCB; and RHR heat exchanger #1 shell discharge flow indication (FI-688A) and low flow alarm at MCB.	1. The system design employs three component cooling water pumps. CCW pump #3 serves as a standby pump that may be aligned by operator action for supplying flow to either CCW heat exchanger #1 or #2 in the event of failure CCW pump #1 or #2. 2. During full power plant operation, one CCW pump and one CCW heat exchanger accommodates the heat removal loads required for plant operation. the circuit breakers of CCW pumps are tripped to close on the generation of a SI "S" signal.
2. Motor Operated Butterfly Valve 1-9370 (valve 1-9371 analogous)	a. Fails to close on demand.	a. Failure reduces the redundancy of valves provided to separate the pump inlet header of CCW system for the forming of two separate loops for CCW flow. No effect on safety for system operation. Isolation valve 1-9371, also closed by the operator, provides backup isolation for loop separation.	a. .Valve position status lights and group monitoring light (valve closed at MCB).	1. Operator closes the valve for the post-accident recirculation phase of ECCS system operation.
3. Motor Operated Butterfly Valve 1-9384 (valve 1-9385 analogous)	a. Fails to close on demand.	a. Failure reduces the redundancy of valves provided to separate the pump discharge header of CCW system for the forming of two separate loops for CCW flow. No effect on safety for system operation. Isolation valve 1-9385, also closed by the operator, provides backup isolation for loop separation.	a. Same failure detection methods as stated for item #2.	1. Same remarks as that stated for item #2.

TABLE 9.2.2-4 FAILURE MODE AND EFFECTS ANALYSIS - COMPONENT COOLING WATER SYSTEM ACTIVE COMPONENTS - SAFE SHUTDOWN AND POST-ACCIDENT OPERATION

Component	Failure Mode	*Effect on System Operation	**Failure Detection Mode	*Remarks
4. Motor Operated Gate Valve 1-9431A (Valve 1-9431B analogous)	a. Fails to open on demand.	a. Same effect on system operation as that stated for item #1.	a. Valve position status lights and group monitoring light (valve open) at MCB; CCW pump #1 discharge header pressure indication (PI-649) at MCB; and RHR heat exchanger #1 shell discharge flow indication (FI-688A) and low flow alarm at MCB.	1. Operator opens the valve for the post-accident recirculation phase of the ECCS system operation.
5. Motor Operated Gate Valve 1-9480A (valve) 1-9480B analogous	a. Fails to close on demand.	a. Failure reduces the redundancy of valves provided for containment isolation of the main pipe line for CCW flow to RC pumps. No effect on safety for system operation. Alternate isolation valve 1-9480B closes to provide backup isolation of pipe line for containment isolation.	a. Same failure detection methods as stated for item #2.	1. Valve is actuated to close upon the generation of a Containment Isolation Phase B “P” signal.
6. Motor Operated Gate Valve 1-9481 (Valve 1-9482 is analogous)	a. Fails to close on demand.	a. Failure reduces the redundancy of valves provided for containment isolation of pipe line for return CCW flow from RC pumps bearing oil coolers. No effect on safety for system operation. Alternate isolation Valve 1-9482 closes to provide isolation of pipe line for containment isolation.	a. Same failure detection methods as stated for item #2.	1. Same remark as stated for item #5.
7. Motor Operated Gate Valve 1-9483 (Valve 1-9484 is analogous)	a. Fails to close on demand.	a. Failure reduces the redundancy of valves provided for containment isolation of pipe line for return CCW flow from RC pump lower bearings and RC pump thermal barriers. No effect on safety for system operation. Alternate isolation valve 1-9484 closes to provide isolation of pipe line for containment isolation.	a. Same failure detection methods as stated for item #2.	1. Same remark as stated for item #5.

TABLE 9.2.2-4 FAILURE MODE AND EFFECTS ANALYSIS - COMPONENT COOLING WATER SYSTEM ACTIVE COMPONENTS - SAFE SHUTDOWN AND POST-ACCIDENT OPERATION

Component	Failure Mode	*Effect on System Operation	**Failure Detection Mode	*Remarks
8. Motor Operated Gate Valve 1-9485	a. Fails to close on demand.	a. Failure reduces the redundancy of provisions provided for containment isolation by preventing outside isolation of the containment through the closing of isolation valve 1-9485. No effect on safety for system operation. Containment isolation is maintained by the closed system design employed to provide CCW flow to the RCDT heat exchanger and to the CVCS excess letdown heat exchanger located inside the containment.	a. Same failure detection methods as stated for item #2.	1. Valve is activated to close upon the generation of a Containment Isolation Phase A “T” signal. 2. System is designed to meet General Design Criterion #57. 3. Check valve 1-9504 is used to prevent reverse flow in case of tube rupture in a heat exchanger and is not required for containment isolation.
9. Motor Operated Gate Valve 1-9486	a. Fails to close on demand.	a. Same effect on system operation as stated for item #8, except isolation outside containment is prevented by isolation valve 1-9486 not closing.	a. Same failure detection methods as stated for item #2.	1. Valve is actuated to close upon the generation of a Containment Isolation Phase A “T” Signal. 2. System is designed to meet General Design Criterion #57.
10. Air Operated Diaphragm Valve 1-LCV-676 (Valve 1-LCV-670 analogous)	a. Fails to close on demand.	a. Failure reduces the redundancy of isolation valves provided to isolate CCW flow to the “gross failed fuel detection system” during post-accident system operation. No effect on safety for system operation. Alternate isolation valve 1-LCV-670 closes to provide backup flow isolation.	a. Same failure detection methods as stated for item #2.	1. Valve is actuated to close upon the generation of an SI “S” Signal.
11. Motor Operated Gate Valve 1-FCV-685	a. Fails to close on demand.	a. Failure results in no automatic isolation upon increased flow in outlet header from RCP thermal barrier. No effect on safety for system operation. Valve can be closed remotely from MCB or alternate isolation valves 1-9483 and 1-9484 can be closed.	a. Valve position status lights and group monitoring light (valve closed at MCB. Local flow and temperature indication in discharge header with high and low flow and high temperature alarms on MCB.	1. Valve is actuated to close on generation of high flow indication.

TABLE 9.2.2-4 FAILURE MODE AND EFFECTS ANALYSIS - COMPONENT COOLING WATER SYSTEM ACTIVE COMPONENTS - SAFE SHUTDOWN AND POST-ACCIDENT OPERATION

Component	Failure Mode	*Effect on System Operation	**Failure Detection Mode	*Remarks
12. Air Operated Butterfly Valve 1-TCV-144	a. Fails to modulate on demand.	a. Failure results in inability of CCW to control flowrate supplied to letdown heat exchanger. No effect on safety for system operation. Letdown flow to letdown heat exchanger can be limited or letdown cooling can be accomplished with excess letdown heat exchanger.	a. Valve position status lights and group monitoring light (valve open) on MCB. Local flow and temperature indication with high and low flow alarms on MCB.	1. Valve fails open on loss of air supply.
13. Air Operated Diaphragm Valve 3CC-D547SA-1 (Valve 3CC-D548SB-1 analogous)	a. Fails to close on demand.	a. Failure reduces the redundancy of isolation valves provided to isolate CCW flow to the sample heat exchangers during post-accident system operation. No effect on safety for system operation.	a. Same failure detection methods as stated for Item 2.	1. Valve is actuated to close upon the generation of an SI “S” Signal.
14. Air Operated Diaphragm Valve 1-9472	a. Fails to open on demand.	a. Failure results in inability to supply CCW to excess letdown heat exchanger. No effect on safety for system operation. Letdown cooling can be accomplished with letdown heat exchanger.	a. Same failure detection methods as stated for item #12.	1. Valve is remotely opened to initiate CCW flow to excess letdown heat exchanger.

Additional analysis provided by ESR 94-00057.

List of acronyms and abbreviations.

CCW - Component Cooling Water

CVCS - Chemical and Volume Control System

ECCS - Emergency Core Cooling System

MCB - Main Control Board

RC - Reactor Coolant

RHR - Residual Heat Removal

SI - Safety Injection

TABLE 9.2.3-3

DEMINERALIZED WATER MAKEUP SYSTEM
DESIGN DATA FOR DWS SYSTEM COMPONENTS

1. Feed Pumps (Clearwell Transfer Pumps)	
Quantity	3 (2 in service and 1 spare)
Capacity	340 gpm each
Total Dynamic Head	160 ft.
Type	Horizontal, Centrifugal
Motor	30 Hp
2. Carbon Absorption Units	
Quantity	2
Diameter	9 ft.
Design Pressure	100 psi
Code	ASME Section VIII
Material	Carbon Steel
Lining	Protective Coatings for Immersion Service
Activated Carbon	250 cu. ft. for each
3. Cation Units	
Quantity	2
Diameter	8 ft. 6 in.
Working Pressure	100 psi
Code	ASME Section VIII
Material	Carbon Steel
Lining	Rubber
Resin	225 cu.ft. for each
4. Vacuum Degasifier	
Quantity	1
Diameter	5 ft.
Working Design	100 psi and full vacuum
Code	ASME Section VIII
Material	Carbon Steel
Lining	Rubber
Packing	
Material	2 in. Polypropylene
Quantity	285 cu. ft.
5. Vacuum Pumps	
Quantity	2 (1 in service and 1 spare)
Material	Iron
Motor	40 Hp
6. Pretreated Water Storage Tank	
Quantity	1
Diameter	47 ft.
Capacity	500,000 gal.
Material	Stainless Steel

Table 9.2.3-3 (Continued)

7.	Degasified Water Transfer Pumps	
	Quantity	3 (2 in service and 1 spare)
	Capacity	340 gpm each
	Total Dynamic Head	230 ft.
	Material	316 SS
	Motor	50 Hp
8.	Anion Units	
	Quantity	2
	Diameter	8 ft.
	Working Pressure	150 psi
	Code	ASME Section VIII
	Material	Carbon Steel
	Lining	Rubber
	Resin	150 cu. ft. for each
9.	Mixed Bed Units	
	Quantity	2
	Diameter	5 ft. 6 in.
	Working Pressure	150 psi
	Code	ASME Section VIII
	Material	Carbon Steel
	Lining	Rubber
	Resin	
	Cation	42 cu. ft. for each
	Anion	42 cu. ft. for each
10.	Acid Storage Tank	
	Quantity	1
	Dimensions (dia x st side)	11 ft. x 11 ft.
	Material	1/2 in. Carbon Steel
11.	Conc. Sulfuric Acid Pumps	
	Quantity	1 (1 in service and 1 spare)
	Material	Carpenter 20
	Capacity	1108 gph at 90 psi
	Type	Metering Pump
	Motor	7 1/2 Hp
12.	Caustic Storage Tank	
	Quantity	1
	Dimensions (dia x st side)	12 ft. x 12 ft. 6 in.
	Material	3/8 in. Carbon Steel
	Heater	Chromolox
13.	Caustic Pumps	
	Quantity	2 (1 in service and 1 spare)
	Material	316 SS
	Capacity	240 gph at 100 psi
	Type	Metering Pump
	Motor	2 Hp

Table 9.2.3-3 (Continued)

14. Hot Water Tank

Quantity	1
Dimensions (dia x ht)	10 ft. x 10 ft.
Working Pressure	100 psi
Code	ASME Section IV
Material	Carbon Steel
Lining	Rubber
Heater	Chromolox

15. Air Blowers

Quantity	2 (1 in service and 1 spare)
Capacity	192 CFM at 10 psi
Motor	15 Hp

16. Heat Exchanger

Quantity	1
Type	Shell and Tube
Material	Carbon Steel
Dimension (dia x length)	1 ft. 4 in. x 5 ft.
Code	ASME
Purpose	To heat water to 60 F when water temp goes below 60 F
Working Pressure	125 psi

17. Demineralized Water Storage Tank

Quantity	1
Capacity	500,000 gal.
Dimension	47 ft. dia. x 40 ft. high
Material	Stainless Steel

18. Demineralized Transfer Pumps

Quantity	2
Material	Stainless Steel
Capacity	300 gpm
Total Dynamic Head	455 ft.

19. Low Sodium Mixed Bet Unit

Quantity	1
Diameter	3'-6"
Working Pressure	150 psi
Code	ASME Section VIII
Material	Carbon Steel
Lining	Rubber
Resin	40 cu. ft.

TABLE 9.2.3-4

PRIMARY MAKEUP SYSTEM

DESIGN DATA FOR PM SYSTEM COMPONENTS

1. Reactor Makeup Water Storage Tank

Quantity	1
Capacity	85,000 gallons
Code	ASME Section III, Class 3
Dimensions	27 ft. dia. x 20 ft. high
Material	Stainless Steel

2. Reactor Makeup Water Pump

Quantity	2
Capacity	150 gpm
Code	ASME Section III, Class 3
T D H	250 ft.
Material	Stainless Steel

TABLE 9.2.6-1

DESIGN DATA FOR CONDENSATE STORAGE SYSTEM

Condensate Storage Tank

Quantity	1
Capacity (gal)	415,000
Height, ft	47
Diameter, ft	40
Design Pressure	Atmospheric
Design Temperature (F)	130
Material	Stainless Steel

Condensate Transfer Pump

Quantity	1
Type	Vertical (in-line)
Capacity (gpm)	800
Total Dynamic Head (ft)	90
Speed (rpm)	1750
Material	Ductile Iron

TABLE 9.2.8-1

ESSENTIAL SERVICES CHILLED WATER SYSTEM COMPONENTS

Each redundant system contains the following:

1. Water Chiller	
Quantity	1
Type	Packaged open centrifugal refrigeration unit with water cooled condensers
a) Capacity, Tons of Refrigeration, each	752
b) Chiller Water Side (Evaporator)	
Flow, gpm	1298
Entering water temperature	57.9°F (at full load, higher temperature will affect leaving water temperature)
Leaving water temperature	44°F
Code	ASME, Section III, Class 3
c) Condenser Water Side	
Flow, gpm	2900 max./2000 min.
Entering water temperature	95°F max.
Leaving water temperature	103.74°F/104.5°F (at full load with max. entering water temperature)
Code	ASME, Section III, Class 3
2. Refrigerant Compressor Motor	
Type	Open, Class 1E
Rating	840 HP, 6600 V, 60 Hz, 3 phase
Insulation	Class B Powerhouse
Enclosure	Drip-proof, Guarded
Code	NEMA
3. Chilled Water Pump	
Quantity	1
Type	Centrifugal
Capacity, gpm	1298
Total Dynamic Head, ft. wg.	170
Code	ASME, Section III, Class 3
4. Chilled Water Pump Motor	
Type	Class 1E
Rating	100 HP, 460 V, 60 Hz, 3 phase
Insulation	Class H
Enclosure	Drip-proof
Code	NEMA MG-1

Table 9.2.8-1 (Continued)

5. Condenser Water Recirculating Pump

Quantity	1
Type	Centrifugal
Capacity, gpm	1000
Total Dynamic Head, feet wg.	48
Code	ASME, Section III, Class 3

6. Condenser Water Recirculating Pump Motor

Type	Class 1E
Nameplate H.P.	20
Rating	460 volts, 3 phase 60 Hz
Enclosure	Dripproof
Insulation	Class H
Standard	NEMA

TABLE 9.2.8-2 ESSENTIAL SERVICES CHILLED WATER SYSTEM SINGLE FAILURE ANALYSIS

COMPONENT IDENTIFICATION AND QUANTITY	FAILURE MODE	EFFECT ON SYSTEM	METHOD OF DETECTION	MONITOR	REMARKS
1) Chilled water piping system	Rupture	a) Loss of chilled water flow.	Pressure differential flow switch in piping.	Low Flow Alarm in C.R.	100% capacity stand-by system is provided.
		b) Increase in supply air temperature to the space from ESF air handling units.	High temperature signal indication.	High temperature indication in C.R.	100% capacity stand-by system is provided.
2) Water Chiller WC-2 (1A-SA) WC-2 (1B-SB)	Fails in operation.	Increase in chilled water temperature.	Temperature indication at chiller outlet.	Common trouble alarm in C.R., may have to investigate locally to determine actual source of trouble. Local temperature indication	100% capacity stand-by system is provided.
3) Chilled Water Pump P-4 (1A-SA) P-4 (1B-SB)	Fails in operation.	Loss of chilled water flow.	Pressure differential flow switch in chilled water piping.	Flow Alarm in C.R.	100% capacity stand-by ESCWS is provided.
4) Pneumatic operated isolation valves	Fails to close.	Isolation of non-safety related part from safety related part	Valve position indicating lights.	Indicating Lights in C.R.	Two are provided in series on redundant emergency elec. power trains.
5) Solenoid valve for chilled water make-up	Fails	Solenoid valve shall close.	Low Water Level Alarm.	Low Water Level Alarm in C.R.	100% capacity stand-by system is provided. No immediate change to stand-by system is required. Chilled water expansion tank has an extra capacity.
6) One emergency electric power train	Fails	System stops operation.	Equipment operation status indication.	Alarms and Indications in C.R.	100% capacity stand-by system is provided.
7) Air Handling Units (ESF)	a) 3-way valve fails to provide flow to AH coil	Increase of space temperature.	High temperature indication.	High temperature indication.	100% capacity stand-by system is provided.
	b) Fan fails to operate.	Increase of space temperature.	Air Flow Switch	Low Air Flow Alarm in C.R.	100% capacity stand-by system is provided.

TABLE 9.2.8-2 ESSENTIAL SERVICES CHILLED WATER SYSTEM SINGLE FAILURE ANALYSIS

COMPONENT IDENTIFICATION AND QUANTITY	FAILURE MODE	EFFECT ON SYSTEM	METHOD OF DETECTION	MONITOR	REMARKS
8) Condenser Water Supplied from Service Water System	a) Inadequate SW supply			Common Trouble Alarm/Annunciation in Main Control Room.	
	b) Valve fails to open on demand	Reduced capacity with eventual chiller shutdown on high refrigerant pressure	None prior to shutdown (upon shutdown main control room will receive “trouble” alarm)	High refrigerant pressure indicator and status light on local panel	For single failure analysis, see Section 9.2.1.
9) Condenser Water Recirculation Pump P-7 (1A-SA) and P-7 (1B-SB)	Fails to operate.	No Short Term Effect - Long term operation may decrease condenser efficiency	None	Condenser pressure local to chiller.	No action required and 100% capacity stand-by system is available.

Additional analysis performed by ESR 94-00056, PCR-7083 and 1364-97477.

TABLE 9.2.9-1

NON-ESSENTIAL SERVICES CHILLED WATER SYSTEM COMPONENTS

1. Chiller

Quantity	2 (in series)
Type	Packaged open centrifugal refrigeration unit with water cooled condenser
Capacity, tons of Refrigeration, each	904 Lead Unit 847 Lag Unit

2. Refrigerant Compressor Motor

Type	Open
Rating	925 HP, 6600V, 60 Hz, 3 phase
Insulation	Class B
Enclosure	Open Drip-proof
Code	NEMA

3. Chilled Water Side (Evaporator)

Chilled Water Side (Evaporator)	Lead Chiller	Lag Chiller
Entering Water Temperature	60°F	51.74°F
Leaving Water Temperature	51.74°F	44°F
Codes	ASME, Section VIII ANSI B9.1	

4. Condenser Water Side

Condenser Water Side	Lead Chiller	Lag Chiller
Flow	5,200 gpm	
Entering Water Temperature	99.76°F	95°F max.
Leaving Water Temperature	104.79°F	99.76°F
Codes	ASME, Section VIII ANSI B9.1	

5. Chilled Water Pumps

Quantity	2 (one operating & one stand-by)
Type	Centrifugal
Capacity gpm	2628
Total Dynamic Head Ft	160

6. Chilled Water Pump Motor

Rating	150 HP, 460V, 60 Hz, 3 phase
Insulation	Class F
Enclosure	Drip-proof
Code	NEMA

TABLE 9.2.10-1

WPB COOLING WATER SYSTEM DESIGN PARAMETERS

GENERAL		
Service water supply temperature, F	95	
WPB cooling water design temperature, F	105/120 (max)	
WPB COOLING WATER SURGE TANK		
Number	1	
Design pressure, psig		
Internal	100	
External	ATM.	
Design temperature, F	140	
Total volume, gallons	1000	
Normal water volume, gallons	500	
WPB COOLING WATER HEAT EXCHANGER		
Number	2	
Design heat transfer Btu./hr.	61.81×10^6	
	Shell	Tube
Design pressure, psig	150	150
Design temperature, F	200	200
Design flow rate, gallons per minute	7000	10,000
Operating inlet temperature, F	122.6	95
Operating outlet temperature, F	105	107.4
Fluid circulated	WPB cooling water	Service water
WPB COOLING WATER PUMP		
Type	Horizontal/centrifugal	
Number	2	
Design pressure, psig	150	
Design temperature, F	125	
Design flow rate, gallons per minute	6000	
Minimum developed head at design flow, ft.	200	

TABLE 9.2.10-3

WPB COOLING WATER SYSTEM FLOW REQUIREMENTS

Equipment Title	Number Units	Used Simul	Cooling Water per Unit (gpm)*	Total Cooling Water Req (gpm)*
Waste Gas Compressors	2	1	50	50
Catalytic Recombiners	2	1	10	10
Waste Evaporators	2	1	780	780
RO Concentrates Evaporator	2	2	562	1,124
RO Module Precoolers	2	2	180	360
RO Module Chillers	2	2	360	720
Volume Reduction System	1	1	67	67
Waste Evap. Conc. Tank Vent Gas Condenser	1	1	15	15
Secondary Waste Evaporator	2	2	1024	2,048
Radiation Monitor	2	2	50	100
Total - normal operation				5,274
- system design				6,000

*Based on maximum temperature of 105 F.

TABLE 9.3.1-1

COMPRESSED AIR SYSTEM COMPONENT DESIGN DATA

Air Compressors

Type	Non-lube rotary screw air cooled 2 stages with intercooler
Quantity	2
Minimum Delivery	682 scfm (includes NSSS requirements)
Design pressure	125 psig

Type	Non-lube centrifugal air cooled 3 stages with intercooler
Quantity	1
Minimum Delivery	1192 scfm (includes NSSS requirements)
Design pressure	125 psig

Aftercoolers

Type	Pipeline
Quantity	3
Design Pressure	125 psig
Service Water Inlet Temperature	95 F

Air Receivers

Quantity	6
Design Pressure	125 psig
Code	ASME VIII, Div 1
Operating Pressure Range, psig	95-125

Air Dryers

Type	Heat-reactivated
Quantity	3
Dew Point (at 100 psig)	-40 F
Design Pressure	125 psig
Code	ASME VIII, Div 1

TABLE 9.3.1-2

SAFETY CLASS VALVES WITH ACCUMULATORS

Valve Tag No	System	Figure No.
2CB-B1SA	Vacuum Relief System	6.2.2-3
2CB-B2SB	Vacuum Relief System	6.2.2-3
2CM-B5SA	Hydrogen Purge System	6.2.2-3
1RC-P527SA-1	Reactor Coolant System	5.1.2-2 6.3.2-2
1RC-P529SB-1	Reactor Coolant System	5.1.2-2 6.3.2-2
2FW-V26SAB-1	Main Feedwater System	10.1.0-3
2FW-V27SAB-1	Main Feedwater System	10.1.0-3
2FW-V28SAB-1	Main Feedwater System	10.1.0-3
3FW-F3SN-1	Main Feedwater System	10.1.0-3
3FW-F5SN-1	Main Feedwater System	10.1.0-3
3FW-F7SN-1	Main Feedwater System	10.1.0-3

TABLE 9.3.2-1

PRIMARY SAMPLING SYSTEM
SAMPLE ROOM NO. 1A

Source No.	Sample Source	Sample Point No.	Design Pressure psig	Design Temp. °F	Operating Pressure psig	Operating Temp. °F
1	RCS Hot Leg	P-1	2485	680	2485	668
2	Pressurizer Liquid Space	P-2	2485	680	2485	668
3	Pressurizer Steam Space	P-3	2485	680	2485	668
4	SIS Accumulator	P-4	700	300	700	120
5	BTRS Demineralizer Inlet	P-5	125	120	125	120
6	BTRS Demineralizer Outlet	P-6	125	120	125	120
7	CVCS Letdown Line at Demin. Inlet	P-7	300	150	125	120
8	CVCS Letdown Line at Demin. Outlet	P-8	300	150	125	120
9	CVCS Volume Control Tank	P-9	75	250	75	110
10	Reactor Makeup Storage Tank	P-14	150	125	100	95
11	SG Blowdown A	P-11	1185	600	1091	557
12	SG Blowdown B	P-12	1185	600	1091	557
13	SG Blowdown C	P-13	1185	600	1091	557

TABLE 9.3.2-1A

SAMPLE POINTS
SAMPLE ROOM NO 1B

			Design		Operating	
Point	Source	Components	press. (psig)	temp. (F)	press. (psig)	temp. (F)
P-5	BTRS Demin Inlet	Grab	125	120	125	120
P-6	BTRS Demin Outlet	Grab	125	120	125	120
P-7	CVCS Letdown Line at Demin Inlet	Grab	300	150	125	120
P-8	CVCS Letdown Line at Demin Outlet	Grab	300	150	125	120
P-9	BRS Evap Concentrate	Grab	150	250	56	223
P-10	BRS Evap Distillate	Grab	150	200	86	200
P-11	BRS Evap Feed Pump Discharge	Grab	150	200	150	140

(Sample points P1, P2, P3, P11, P12, P13, S1, S2, and S3 are cooled)

(Sample points P1, P2, P3, P4, P11, P12, P13, P14, S1, S2, and S3 are reduced in pressure.)

TABLE 9.3.2-2

SECONDARY SAMPLE SYSTEM IN-LINE ANALYZER INSTRUMENTATION

Sample Point	Grab	pH	Cation Cond.	Total Cond.	Dissolved Oxygen	Hydrazine	Sodium	Iron and Copper	Total
1. Condensate Pump A&B Discharge (3 points/1 line)	Yes	X	X	X	X	X	X	X[3]	7
2. Condensate Polisher Vessel A	Yes		X	X			X[1]		3
3. Condensate Polisher Vessel B	Yes		X	X			X[1]		3
4. Condensate Polisher Vessel C	Yes		X	X			X[1]		3
5. Condensate Polisher Vessel D	Yes		X	X			X[1]		3
6. Condensate Polisher Vessel E	Yes		X	X			X[1]		3
7. Condensate Polisher Vessel F	Yes		X	X			X[1]		3
8. Condensate Polishers Discharge	Yes		X	X	X		X	X[4]	5
9. Heater Drain (2 points/1 line)	Yes	X	X	X				X[5]	4
10. Feedwater	Yes	X	X	X	X	X	X	X[8]	7
11. Steam Generator Blowdown A	Yes	X	X	X			X	X[5]	5
12. Steam Generator Blowdown B	Yes	X	X	X			X	X[4]	5
13. Steam Generator Blowdown C	Yes	X	X	X			X	X[3]	5
14. Main Steam A	Yes	X	X	X					3
15. Main Steam B	Yes	X	X	X					3
16. Main Steam C	Yes	X	X	X					3
17. Steam Generator Blowdown Flash Tank Outlet	Yes							X[6]	1
18. Condensate Storage Tank	Yes	X	X	X	X				4
19. Demineralized Water	Yes								0
20. SG Blowdown Demin 1A	Yes		X	X			X[7]	X[5]	4
21. SG Blowdown Demin 1B	Yes		X	X			X[7]		3
22. SG Blowdown Demin 1C	Yes		X	X			X[7]		3
Total		10	20	20	4	2	15	9	80

[1] The six polisher vessel sample points are monitored using one sodium instrument.
[2] Deleted by Amendment No. 55.
[3, 4, 5, 6] Two iron and copper monitors analyze 8 sample points.
[7] The three SG blowdown demins are monitored using one sodium instrument.
[8] Feedwater is monitored using a separate dissolved oxygen analyzer and iron and copper monitor.

TABLE 9.3.2-2a

STEAM CYCLE SAMPLING SYSTEM
TURBINE BUILDING

Sample Point	Components	Design press. (psig)	Design temp. (F)	Operating press. (psig)	Operating temp. (F)
S9 MSR Drain Tank A & B	Grab				
S10 MSR A & B Crossover Piping	Grab				
S11 Extraction Steam/LP Turbine A & B 14th Stage	Grab				

TABLE 9.3.2-2b

SECONDARY SAMPLING SYSTEM

Sample No.	Sample Source	Design Pressure psig	Design Temp. °F	Operating Pressure psig	Operating Temp. °F
1	Condensate Pumps A & B Discharge	300	140	250	126
2	Condensate Polisher Vessel A	300	140	250	126
3	Condensate Polisher Vessel B	300	140	250	126
4	Condensate Polisher Vessel C	300	140	250	126
5	Condensate Polisher Vessel D	300	140	250	126
6	Condensate Polisher Vessel E	300	140	250	126
7	Condensate Polisher Vessel F	300	140	250	126
8	Condensate Polisher Discharge	300	140	250	126
9	Heater Drain Pump Discharge Nos. A & B	663	410	560	380
10	Feedwater	2000	450	1700	435
11	Steam Generator Blowdown 'A'	1185	600	1091	557
12	Steam Generator Blowdown 'B'	1185	600	1091	557
13	Steam Generator Blowdown 'C'	1185	600	1091	555
14	Main Steam No. 1	1185	600	1091	557
15	Main Steam No. 2	1185	600	1091	557
16	Main Steam No. 3	1185	600	1091	557
17	Steam Generator Blowdown Flash Tank Outlet	170	400	150	366
18	Condensate Storage Tank	Atmospheric	Ambient	Atmospheric	Ambient
19	SG Blowdown Demin 1A	150	200	120	150
20	SG Blowdown Demin 1B	150	200	120	150
21	SG Blowdown Demin 1C	150	200	120	150
22	MSR 1A-NNS Crossover Piping to LP Turbine A	250	550	210	519
23	MSR 1B-NNS Crossover Piping to LP Turbine A	250	550	210	519
24	MS Drain Tank 1A-NNS Discharge to LP Heater 4 (1A-NNS)	250	410	207	391
25	MS Drain Tank 1B-NNS Discharge to LP Heater 4 (1B-NNS)	250	410	207	391
26	Extraction Steam L.P. Turbine A 14th Stage	100	340	40	286
27	Extraction Steam L.P. Turbine B 14th Stage	100	340	40	286

TABLE 9.3.4-1

CHEMICAL AND VOLUME CONTROL SYSTEM
GENERAL SYSTEM DESIGN PARAMETERS

Seal water supply flowrate, for three reactor coolant pumps, nominal (gpm)	24
Seal water return flowrate, for three reactor coolant pumps, nominal (gpm)	9
Letdown flow:	
Normal (gpm)	105
Maximum (gpm)	120
Charging flow (excludes seal water):	
Normal (gpm)	90
Maximum (gpm)	105
Temperature of letdown reactor coolant entering system (F)	555
Temperature of charging flow directed to reactor coolant system (F)	501
Temperature of effluent directed to boron recycle system (F)	115
Centrifugal charging pump miniflow, each (gpm)	60

TABLE 9.3.4-2

CHEMICAL AND VOLUME CONTROL SYSTEM
PRINCIPAL COMPONENT DATA SUMMARY

Centrifugal Charging Pumps	
Number	3
Design pressure (psig)	2800
Design temperature (F)	300
Design flow (gpm)	150
Design head (ft.)*	6300
Material	Austenitic Stainless Steel

Boric Acid Transfer Pumps	
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.)	8.62×10^6	
	Shell Side (Letdown)	Tube Side (Charging)
Design pressure (psig)	2,485	2,735
Design temperature (F)	650	650
Design flow (lb/hr.)	29,800	22,400
Inlet temperature (F)	554	130
Outlet temperature	290	501
Fluid	Borated Reactor Coolant	Borated Reactor Coolant
Material	Austenitic Stainless Steel	Austenitic Stainless Steel

*Maximum for three pumps.

Table 9.3.4-2 (Continued)

Letdown Heat Exchanger		
Number	1	
Heat transfer rate at design conditions (Btu/hr.)	16.1×10^6	
	Shell Side	Tube Side (Letdown)
Design pressure (psig)	218	600
Design temperature (F)	250	400
Design mode		
Flow (lb/hr.)	551,000	59,600
Inlet temperature (F)	105	380
Outlet temperature (F)	134	115
Normal Mode		
Flow (lb/hr.)	76,500	29,800
Inlet temperature (F)	105	290
Outlet temperature (F)	173	115
Fluid	Component Cooling Water	Borated Reactor Coolant
Material	Carbon Steel	Austenitic Stainless Steel

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)	190	2485
Design temperature (F)	250	650
Design flow (lb/hr.)	129,000	12,410
Inlet temperature (F)	105	557
Outlet temperature (F)	145	165
Fluid	Component Cooling Water	Borated Reactor Coolant
Material	Carbon Steel	Austenitic Stainless Steel

Seal Water Heat Exchanger		
Number	1	
Heat transfer rate at design conditions (Btu/hr.)	1.5×10^6	
	Shell Side	Tube Side
Design pressure (psig)	181	181
Design temperature (F)	250	250
Design flow (lb/hr.)	115,000	64,075
Inlet temperature (F)	105	138
Outlet temperature (F)	118	115
Fluid	Component Cooling Water	Borated Reactor Coolant
Material	Carbon Steel	Austenitic Stainless Steel

Table 9.3.4-2 (Continued)

Moderating Heat Exchanger

Number	1	
Heat transfer rate at design conditions (Btu/hr.)	2.53×10^6	
	Shell Side	Tube Side
Design pressure (psig)	300	300
Design temperature (F)	200	200
Design flow (lb/hr.)	59,600	59,600
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
Fluid	Borated Reactor Coolant	Borated Reactor Coolant
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	59,600
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	59,600
Inlet temperature, boron release mode (F)	90	123.7
Outlet temperature boron release mode	99.4	96.1
Fluid	Chilled Water	Borated Reactor Coolant
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	300	600
Design temperature (F)	200	400
Design flow (lb/hr.)	59,600	44,700
Inlet temperature (F)	115	280
Outlet temperature (F)	140	246.7
Fluid	Borated Reactor Coolant	Borated Reactor Coolant
Material	Austenitic Stainless Steel	Austenitic Stainless Steel

Table 9.3.4-2 (Continued)

Volume Control Tank	
Number	1
Volume ($ft.^3$)	300
Design pressure (psig)	75
Design temperature (F)	250
Material	Austenitic Stainless Steel
Boric Acid Tank	
Number	1
Usable capacity, each (gal.)	36,000
Design pressure	Atmospheric
Design temperature (F)	200
Material	Austenitic Stainless Steel
Batching Tank	
Number	1
Capacity (gal.)	400
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
Reactor Coolant Pump Standpipes	
Number	3
Capacity (gal.)	9.75
Design pressure (psig)	50
Design temperature (F)	212
Material	Austenitic Stainless Steel

Table 9.3.4-2 (Continued)

Mixed Bed Demineralizers	
Number	2
Design pressure (psig)	300
Design temperature (F)	250
Design flow (gpm)	120
Resin volume, each ($ft.^3$)	30
Material	Austenitic Stainless Steel
Cation Bed Demineralizer	
Number	1
Design pressure (psig)	300
Design temperature (F)	250
Design flow (gpm)	60
Resin volume ($ft.^3$)	20
Material	Austenitic Stainless Steel
Thermal Regeneration Demineralizers	
Number	4
Design pressure (psig)	300
Design temperature (F)	250
Design flow (gpm)	120
Resin volume ($ft.^3$)	74
Material	Austenitic Stainless Steel
Reactor Coolant Filter	
Number	1
Design pressure	400
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)	2735
Design temperature (F)	200
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)	400
Design temperature (F)	250
Design flow (gpm)	150
Particulate retention	98% of ≥ 25 micron size
Material, vessel	Austenitic Stainless Steel

Table 9.3.4-2 (Continued)

Boric Acid Filter	
Number	1
Design pressure (psig)	400
Design temperature (F)	250
Design flow (gpm)	150
Particle retention	98% of ≥ 25 micron size
Material, vessel	Austenitic Stainless Steel

Letdown Orifice	45 gpm	60 gpm
Number	1	2
Design flow (lb/hr)	22,400	29,800
Differential pressure at design flow (psig)	1700 ± 100	1700 ±100
Design pressure (psig)	2485	2485
Design temperature (F)	650	650
Material	Austenitic Stainless Steel	Austenitic Stainless Steel

No. 1 Seal Bypass Orifices	
Number	3
Design flow (gpm)	1
Differential pressure at design flow (psig)	300
Design pressure (psig)	2485
Design temperature (F)	250
Material	Austenitic Stainless Steel

Boric Acid Blender	
Number	1
Design pressure (psig)	150
Design temperature (F)	250
Material	Austenitic Stainless Steel

Chillers	
Number	2
Capacity (Btu/hr.)	1.66×10^6
Design flow (gpm)	400
Inlet temperature (F)	47.3
Outlet temperature (F)	39

TABLE 9.3.4-3

BORON RECYCLE SYSTEM
PRINCIPAL COMPONENT DATA SUMMARY

Recycle Evaporator Feed Pumps	
Number	2
Design pressure (psig)	150
Design temperature (F)	200
Design flow (gpmP	30/100
Design head (ft.)	330 maximum
Material	Austenitic Stainless Steel
Recycle Holdup Tank	
Number	1
Usable Capacity, each (gal.)	84,000
Design pressure	Atmospheric
Design temperature (F)	200
Material	Austenitic Stainless Steel
Recycle Evaporator Reagent Tank	
Number	1
Capacity (gal.)	5
Design pressure (psig)	150
Design temperature (F)	200
Material	Austenitic Stainless Steel
Recycle Monitor Tanks	
Number	2
Capacity (gal.)	10,800
Design pressure (psig)	Atmospheric
Design temperature (F)	200
Material	Stainless Steel
Recycle Evaporator Feed Demineralizers	
Number	2
Design pressure (psig)	150
Design temperature (F)	200
Design flow (gpm	120
Resin volume, (ft.^{3})	30
Material	Austenitic Stainless Steel
Recycle Evaporator Condensate Demineralizers	
Number	2
Design pressure (psig)	150
Design temperature (F)	200
Design flow (gpm	35
Resin volume, (ft.^{3})	20
Material	Austenitic Stainless Steel

TABLE 9.3.4-3 (Continued)

Recycle Evaporator Feed Filter	
Number	1
Design pressure (psig)	400
Design temperature (F)	200
Design flow (gpm	150
Particle retention	98% of ≥ 5 micron size
Material (vessel)	Austenitic Stainless Steel
Recycle Evaporator Concentrates Filter	
Number	1
Design pressure (psig)	400
Design temperature (F)	250
Design flow (gpm)	35
Particle retention	98% of ≥ 25 micron size
Material, vessel	Austenitic Stainless Steel
Recycle Evaporator Package	
Number	1
Design flow (gpm)	15
Concentration of concentrate, boric acid (wt. percent)	4
Concentration of condensate	<10 ppm boron as H_3BO_3
Material	Austenitic Stainless Steel
Recycle Holdup Tank Vent Ejector	
Number	1
Design pressure (psig)	150
Design temperature (F)	200
Recycle Holdup Tank Vent Ejector	
Suction flow (scfm)	1
Motive flow (scfm)	40
Material	Carbon Steel
Recycle Evaporator Condensate Filter	
Number	1
Design pressure (psig)	400
Design temperature (F)	250
Design flow (gpm)	35
Particle retention	98% of ≥ 25 micron size
Material (vessel)	Austenitic Stainless Steel

TABLE 9.3.4-4 FAILURE MODE AND EFFECTS ANALYSIS- CHEMICAL ND VOLUME CONTROL SYSTEM ACTIVE COMPONENTS – 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-LCV-459 (1-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-LCV-460) provides backup letdown flow isolation.	a. Valve Position indication 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 the letdown orifice isolation valves and may not be opened or closed manually from the CB if any of these valves is at an open position.
	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 a 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 at CB; letdown flow indication (FI-150) and charging flow temperature indication (TI-123) at CB; letdown pressure indication (PI-145) at CB; and VCT level indication (LI-115.1) and low level alarm at CB.	
c. Air diaphragm operated globe valve 1-8149A (1-8149B and 1-8149C analogous)	b. Fails open.	b. Charging and Volume Control – letdown flow.	a. Failure prevents isolation of normal letdown flow through regenerative heat exchanger. No effect on safe shutdown operation.	a. Valve position indication at CB.	1. Valve 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, the generation of a low level PRZ signal or closing of letdown isolation valves (1-LCV-459 and 1-LCV-460) upstream of the regenerative heat exchanger.
	c. Fails closed.	c. 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 opening letdown orifice isolation valves 1-8149B and 1-8149C. If common mode failure (loss of instrument air) prevents opening of these valves 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 the PRZ.	1. Same methods of detection as those state for item #1, failure mode “Fails closed.”	

TABLE 9.3.4-4 FAILURE MODE AND EFFECTS ANALYSIS- CHEMICAL ND VOLUME CONTROL SYSTEM ACTIVE COMPONENTS – NORMAL PLANT OPERATION AND SAFE SHUTDOWN

Component	*Failure Mode	CVCS Operation Function	*Effect on System Operation and Shutdown	**Failure Detection Method	*Remarks
3. Air diaphragm operated globe valve 1-8152	a. Fails closed.	a. Charging and Volume Control – letdown flow	a. Failure blocks normal letdown flow to VCT. However, the letdown will continue from the RCS via relief valve 1-8117 which discharges to the PRT. Minimum letdown flow requirements for boration of RCS to a safe shutdown concentration level may be met by the letdown path to the PRT or 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.	a. Valve position indication at CB; letdown flow indication (FI-150) at CB; letdown pressure indication (PI-145) at CB; VCT level indication (LI-115.1) and low level alarm at CB; close position group monitoring light at CB; and relief valve discharge temperature indication (TI-141) and alarm at CB.	1. Valve 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 at CB.	
4. Air diaphragm operated globe valve 1-TCV-381B	a. Fails open.	a. Boron Concentration Control – born thermal regeneration (boration).	a. Failure inhibits use of BTRS for load follow operation (boration) due to low temperature of letdown flow entering BTRS demineralizers. No effect on operations to bring reactor to a safe shutdown condition	a. BTR demineralizer inlet flow temperature indication (TI-381) at CB if BTRS is in operation.	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.
	b. Fails closed.	b. Boron Concentration Control – boron thermal regeneration (boration).	b. Failure inhibits 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 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 valve position indication at CB.	2. BTRS operation is not required in operations of CVCS systems used to bring the reactor a safe shutdown condition.

TABLE 9.3.4-4 FAILURE MODE AND EFFECTS ANALYSIS- CHEMICAL ND VOLUME CONTROL SYSTEM ACTIVE COMPONENTS – NORMAL PLANT OPERATION AND SAFE SHUTDOWN

Component	*Failure Mode	CVCS Operation Function	*Effect on System Operation and Shutdown	**Failure Detection Method	*Remarks
5. Air diaphragm operated globe valve 1-PCV-145	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. Valve (1-TCV-143_ changes position to divert flow to VCT. Boration of RCS safe shutdown concentration level is possible with valve failing open.	a. Letdown heat exchanger tube discharge flow indication (FI-150) and high flow alarm at CB; temperature indication (TI-143) and high temperature alarm at CB; and pressure indication (PI-145) at CB.	1. Same remark as stated for item #4, 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 “Fails closed.”	b. Letdown heat exchanger discharge flow indication (FI-150), and pressure indication (PI-145) and high pressure alarm at CB.	
6. Air diaphragm operated three way valve 1-TCV-143	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 inhibits 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. If BTRS is in operation, BTR demineralizer return flow indication (FI-385).	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. Valve opens for flow to VCT on “High Letdown Temperature” or on “High Letdown Reheat HX Outlet Temperature.”
	b. Fails open for flow only to mixed bed demineral izer.	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 (FI-385)	2. Technical specifications provide a limit on RCS activity.

TABLE 9.3.4-4 FAILURE MODE AND EFFECTS ANALYSIS- CHEMICAL ND VOLUME CONTROL SYSTEM ACTIVE COMPONENTS – NORMAL PLANT OPERATION AND SAFE SHUTDOWN

Component	*Failure Mode	CVCS Operation Function	*Effect on System Operation and Shutdown	**Failure Detection Method	*Remarks
7. Air diaphragm operated globe valve 1-8153 (1-8154 analogous)	a. Fails closed.	a. Charging and Volume Control – excess letdown flow.	a. 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. 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 at CB and excess letdown heat exchanger outlet pressure indication (PI-138) and temperature indication (TI-139) 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 – excess letdown flow.	b. Failure reduces redundancy of providing excess letdown flow isolation during normal plant operation and for plant startup. No effect on system operation. Alternate isolation valve (1-8154) can be closed to provide backup flow isolation of excess letdown line.	b. Valve position indication at CB.	
8. Air diaphragm operated globe valve 1-HCV-137	a. Fails closed	a. Charging and Volume Control – excess letdown flow	a. Same effect on system operation as stated for item #7, failure mode "Fails closed".	a. Same methods of detection as those stated for item #7, failure mode "Fails closed," except no valve position indication at CB.	1. Same remark as that stated above for item #7.
	b. Fails open.	b. Charging and Volume Control – excess letdown flow.	b. Failure prevents manual adjustment at CB of RCS system pressure downstream of excess letdown. Heat exchanger to a lower pressure consistent with No. 1 seal leakoff backpressure requirements. Relief valve (1-8121) opens in seal return line to release pressure to PRT. No effect on system operation. Excess letdown line can be isolated.	b. Excess letdown heat exchanger outlet pressure indication (PI-138) and temperature indication (TI-139) at CB.	
9. Air diaphragm operated diaphragm valve 1-LCV-406 (1-LCV-407, and 1-LCV-408 analogous)	a. Fails closed.	a. Charging and Volume Control – seal water flow.	a. No automatic 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 and low standpipe level alarm at CB>	1. Same remark as that stated for item #7 in regards to valve design.
	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 automatic 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 and high standpipe level alarm at CB.	2. Low level standpipe alarm conservatively set to allow additional time for RC pump operation without a complete loss of seal water from being injected to No. 3 seal after sounding of alarm.

TABLE 9.3.4-4 FAILURE MODE AND EFFECTS ANALYSIS- CHEMICAL ND VOLUME CONTROL SYSTEM ACTIVE COMPONENTS – NORMAL PLANT OPERATION AND SAFE SHUTDOWN

Component	*Failure Mode	CVCS Operation Function	*Effect on System Operation and Shutdown	**Failure Detection Method	*Remarks
10. Motor operated globe valve 1-8112 (1-8100 analogous)	a. Fails open.	a. Charging and Volume Control – seal water flow and excess letdown flow.	a. Failure has no effect on CVCS operating 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 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. If normal letdown and excess letdown flow is not available for safe shutdown operation, plant operator can borate RCS to a safe shutdown concentration using steam space available in PRZ.	b. Valve position indication at CB; group monitoring light at CB; and seal water return flow recording (FR-154A and -154B) and low seal water return flow alarm at CB.	
11. Motor operated gate valve 1-8107 (1-8108 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 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.

TABLE 9.3.4-4 FAILURE MODE AND EFFECTS ANALYSIS- CHEMICAL ND VOLUME CONTROL SYSTEM ACTIVE COMPONENTS – NORMAL PLANT OPERATION AND SAFE SHUTDOWN

Component	*Failure Mode	CVCS Operation Function	*Effect on System Operation and Shutdown	**Failure Detection Method	*Remarks
	b. Fails closed.	b. Charging and Volume Control – charging flow.	b. Failure inhibits use of normal charging line of 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 and group monitoring light (valve closed) at CB; charging flow indication (FI-122A) and low flow alarm at CB; PRZ level recording and low level alarm at CB letdown temperature indication (TI-140) and high temperature alarm at CB; VCT level indications (LI-115.1) and high level alarm at CB.	2. Refer to ECCS FMEA.
12. Air diaphragm operated globe valve 1-HCV-186	a. Fails open.	a. Charging and Volume Control – seal water flow.	a. Failure prevents manual adjustment at CB of seal water flow to RC pump seal leading to an increase 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 concentration level and makeup of coolant during operations to bring reactor to a safe shutdown condition is still possible through normal charging flow path. Control of correct seal water flow to RC pumps can be achieved by opening and adjusting manual globe bypass valve 1-8389 and closing motor operated globe valve 1-8105.	a. Seal water flow indications (FI-124A, -127A and -130A) at CB.	a. Same remark as that stated for item #4 in regards to design of valve.
	b. Fails closed.	b. Charging and Volume Control – seal water flow.	b. Failure precludes normal seal injection flow to RC pump seals. Normally closed globe valve 1-8389 can be opened to provide seal injection flow. Thermal barrier cooling (CCS) provides independent means of cooling the RC pump seals and bearing.	b. Seal injection flow indications (FI-130A, -127A, and -124A) and low flow alarms at CB.	
13. Motor operated gate valve 1-8106 (motor operated globe valves 1-8109A, -8109B, and -8109C analogous)	a. Fails open.	a. Charging and Volume Control – charging flow and seal water flow.	a. Failure has no effect on CVCS operating 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 at CB.	1. Same remark as that stated for item #11. 2. Refer to ECCS FMEA.
	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 at CB; group monitoring light (valve closed) and alarm at CB.	

TABLE 9.3.4-4 FAILURE MODE AND EFFECTS ANALYSIS- CHEMICAL ND VOLUME CONTROL SYSTEM ACTIVE COMPONENTS – NORMAL PLANT OPERATION AND SAFE SHUTDOWN

Component	*Failure Mode	CVCS Operation Function	*Effect on System Operation and Shutdown	**Failure Detection Method	*Remarks
14. Air diaphragm operated globe valve 1-8146	a. Fails open	a. Charging and Volume Control – charging flow	a. Failure has no effect on CVCS operating 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 at CB.	1. Same remark as that stated for item #4 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 (1-8147).	b. Valve position indication at CB; charging flow indication (FI-122A) and low flow alarm at CB; PRZ level recording (LR-459) and low level alarm at CB; letdown temperature indication (TI-140) and high temperature alarm at CB; and VCT level indications (LR-115.1) and high level alarm at CB.	
15. Air diaphragm operated globe valve 1-8147	a. Fails closed	a. Charging and Volume Control – charging flow.	a. Failure reduces redundancy of charging flow paths to RCS. No effect on CVCS operations during normal plant operation or safe shutdown operation. Normal charging flow path remains available for charging flow.	a. Valve position indication at CB.	1. Same remark as that stated for item #4 in regards to design of valve.
	b. Fails open.	b. Charging and Volume Control – charging flow	b. Same effect on system operation and shutdown as that stated above for item #14, failure mode “Fails open,” if alternate charging line is in use.	b. Valve position indication at CB.	
16. Air diaphragm operated globe valve 1-8145	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 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 at CB and PRZ pressure recording (PR-444) and low pressure alarm at CB.	1. Same remark as that stated for item #7 in regards to design of valve.

TABLE 9.3.4-4 FAILURE MODE AND EFFECTS ANALYSIS- CHEMICAL ND VOLUME CONTROL SYSTEM ACTIVE COMPONENTS – NORMAL PLANT OPERATION AND SAFE SHUTDOWN

Component	*Failure Mode	CVCS Operation Function	*Effect on System Operation and Shutdown	**Failure Detection Method	*Remarks
	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 at CB.	
17. Air diaphragm operated globe valve 1-FCV-122	a. Fails open.	a. Charging and Volume Control – charging flow.	a. Failure prevents adjustment of charging flow to RCS. No effect on bringing reactor to a safe shutdown condition	a. Charging flow indication (FI-122A) and high flow alarm at CB, and PRZ level recording (LR-459) and high level alarm at CB.	1. Same remark as that stated for item #4 in regards to design of valve.
	b. Fails closed.	b. Charging and Volume Control – charging flow.	b. Failure inhibits 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. Charging flow indication (FI-122A) and low flow alarm at CB; PRZ level recording (LR-459) and low level alarm at CB; letdown temperature indication (TI-140) and high temperature alarm at CB; and VCT level indications (LI-115.1) and high level alarm at CB.	
18. Centrifugal charging pump #1 APCH (Pumps #2 and #3 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. No effect on normal plant operation or bringing reactor to a safe shutdown condition. One of alternate pumps can be started.	a. Pump circuit breaker position indication (open) at CB; circuit breaker close position monitor light for group monitoring of components at CB; common pump breaker trip alarm at CB; charging flow indication (FI-122A) and seal water flow indications (FI-130a, -124A, and -127A) and low flow alarms at CB; PRZ level recording (LR-459) and low level alarm at CB; low charging pump discharge header pressure (PI-121); high letdown temperature indication (TI-140) and alarm; and increasing VCT level.	1. Flow rate for a centrifugal charging pump is controlled by a modulating valve (1-FCV-122) in discharge line from the centrifugal charging pumps.

TABLE 9.3.4-4 FAILURE MODE AND EFFECTS ANALYSIS- CHEMICAL ND VOLUME CONTROL SYSTEM ACTIVE COMPONENTS – NORMAL PLANT OPERATION AND SAFE SHUTDOWN

Component	*Failure Mode	CVCS Operation Function	*Effect on System Operation and Shutdown	**Failure Detection Method	*Remarks
19. Air diaphragm operated globe valve 1-8156	a. Fails closed.	a. Chemical Control, Purification and Makeup-oxygen control.	a. Failure blocks hydrogen flow to VCT and leads to loss of venting of VCT (vent valve 1-PCV-1092 closes on low VCT pressure) 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 (PI-117) and low pressure alarm at CB.	1. Valve is designed to fail "closed. 2. Plant's technical specification sets limits on RCS activity level.
20. Motor operated gate valve 1-LCV-115C (1-LCV-115E analogous)	a. Fails open.	a. Charging and Volume Control – charging flow and seal water flow.	a. Failure has no effect on CVCS during normal plant operation and bringing reactor to 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 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 emergency low water 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 (2,400-2,600 ppm) coolant from the RWST to suction of charging pumps can be established from the CB by the operator through the opening of RWST isolation valves (1-LCV-115D and 1-LCV-115B).	b. Valve position indication at CB; group monitoring light and alarm (valve closed) at CB; charging flow indication (FI-122A) and seal water flow indications (FI-130A, -124A, and -127A) and low flow alarms at Cb; and PRZ level recording (LR-459) and low level alarm at CB.	2. Refer to ECCS FMEA.
21. Air diaphragm operated diaphragm valve 1-PCV-1092	a. Fails closed.	a. Chemical Control, Purification and Makeup-oxygen control.	a. Failure blocks venting of VCT Gas mixture to gas waste processing system for stripping of fission products from RCS coolant during normal plant operation. No effect on operation to bring the reactor to a safe shutdown condition.	a. Valve position indication at CB and VCT pressure indication (PI-117) at CB.	1. Same remark as that stated for item #7 in regards to valve design. 2. Same remark as that stated for item #19 in regards to RCS activity.
22. Air diaphragm operated diaphragm valve 1-FCV-113B	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 reactor coolant by reactor makeup water and blocks fluid flow for boration of the reactor coolant when bringing the reactor to a safe shutdown condition. Boration (at B A tank boron concentration level) of RCS coolant to bring the reactor to a safe shutdown condition is possible by opening of alternate B A tank isolation valve (1-8104) at CB.	a. Valve position indication at CB; total makeup flow deviation alarm at CB; and VCT level indications (LI-115.1) and low level alarms (low and emergency low) at CB.	1. Same remark as that stated for item #7 in regards to valve design.

TABLE 9.3.4-4 FAILURE MODE AND EFFECTS ANALYSIS- CHEMICAL ND VOLUME CONTROL SYSTEM ACTIVE COMPONENTS – NORMAL PLANT OPERATION AND SAFE SHUTDOWN

Component	*Failure Mode	CVCS Operation Function	*Effect on System Operation and Shutdown	**Failure Detection Method	*Remarks
	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 at CB.	
23. Air diaphragm operated diaphragm valve 1-FCV-114A	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 #7 in regards to valve design.
	b. Fails open.	b. Boron Concentration Control – reactor makeup control – dilution and alternate dilution.	b. Failure allows for alternate dilute mode type operation for system operation of boration and auto makeup of RCS coolant. No effect on CVCS operation during normal plant operation during normal plant operation and when bringing the reactor to a safe shutdown condition.	b. Valve position indication at CB.	
24. Air diaphragm operated globe valve 1-FCV-113A	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 from BA tanks cannot be automatically controlled.	a. Boric acid flow recording (FR-113) and flow deviation alarm at CB.	1. Same remark as that stated for item #4 in regards 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 (1-8104) at CB.	b. Boric acid flow recording (FR-113) and flow deviation alarm at CB.	

TABLE 9.3.4-4 FAILURE MODE AND EFFECTS ANALYSIS- CHEMICAL ND VOLUME CONTROL SYSTEM ACTIVE COMPONENTS – NORMAL PLANT OPERATION AND SAFE SHUTDOWN

Component	*Failure Mode	CVCS Operation Function	*Effect on System Operation and Shutdown	**Failure Detection Method	*Remarks
25. Air diaphragm operated globe valve 1-FCV-114B	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 shutdown condition.	a. VCT level indications (LI-115.1) and low level alarms (low and emergency low) and CB; and total makeup water flow recording (FR-114) and flow deviation alarm at CB.	1. Same remark as that stated for item #7 in regards to valve design.
26. Motor operated globe valve 1-8104	a. Fails closed.	a. Boron Concentration – reactor makeup control – boration and auto makeup.	a. Failure reduces redundancy of flow paths for supplying boric acid solution from BA tanks to RCS via charging pumps. No effect on CVCS operation during normal plant operation or safe shutdown operation. Normal flow paths via RMCS and gravity feed line remain available for boration of RCS coolant.	a. Valve position indication at CB and flow indication (FI-110) 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-FCV-113 A and 1-8104), borated water from BAT via gravity feed line or borated water from RWST is available by opening isolation valve 1-LCV-115B or 1-LCV-115D
	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 from BA tanks cannot be automatically controlled.	b. Valve position indication at CB and flow indication (FI-110) at CB.	
27. Boric acid transfer pump #1 APBA (BA transfer pump #2 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 #2 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 (PI-105).	1. Both BA transfer pumps operate simultaneously for RMCS boration operation.
28. Air diaphragm operated three way valve LCV-115A	a. Fails open for flow only to BRS recycle holdup tank	a. Charging and Volume Control – letdown flow	a. Failure diverts normal letdown flow from VCT to BRS recycle holdup tank, resulting in excessive use of RMCS. No effect on operation to bring reactor to a safe shutdown condition.	a. VCT water level indication (LI-115.1) and low level alarm at CB; and increased water level in BRS recycle holdup tank.	1. Valve is designed to fail open for flow to VCT and is electrically wired so that electrical control solenoids for valve are energized for flow to BRS recycle holdup tank valve opens to flow to BRS recycle holdup tank on high VCT water level signal.

TABLE 9.3.4-4 (Continued)

Footnotes:

*See list below 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.

List of acronyms and abbreviations

BA	-	Boric Acid
BTR	-	Boron Thermal Regeneration
BTRS	-	Boron Thermal Regeneration System
CB	-	Control Board
CCS	-	Component Cooling System
CVCS	-	Chemical and Volume Control System
Demin.	-	Demineralizer
PRT	-	Pressurizer Relief Tank
PRZ	-	Pressurizer
RC	-	Reactor Coolant
RCDT	-	Reactor Coolant Drain Tank
RCS	-	Reactor Coolant System
RHRS	-	Residual Heat Removal System
RWST	-	Refueling Water Storage Tank
RMCS	-	Reactor Makeup Control System
VCT	-	Volume Control Tank

TABLE 9.4.0-1

NOMINAL OUTDOOR AND INDOOR TEMPERATURES AND HUMIDITIES DURING NORMAL PLANT OPERATION

1- OUTDOOR TEMPERATURES AND RELATIVE HUMIDITIES

A-	The outdoor temperatures are taken from the ASHRAE 'Handbook of Fundamentals" for Raleigh-Durham Airport, North Carolina. The summer design temperatures are exceeded approximately one percent of the 2928 hours, or 30 hours, during June through September. The winter temperature will be below the design point approximately one percent of the 2160 hours, or 22 hours for the winter months of December, January, and February. Year-round relative humidity at Raleigh-Durham, North Carolina have been extracted from the Table 2.3.2-17. See Section 2.3 for other offsite climatological data. These temperatures are used for calculation of heat transmission losses or gains across building exterior walls and for calculation of heating and cooling loads for all structures except those listed in paragraph B.	Summer 95°F DB 79°F WB Winter 16°F DB
B-	Values of annual extreme temperatures at Raleigh-Durham, North Carolina (see Table 2.3.2-12) are based on 32 years of record ending in 1977. These temperatures are used for outdoor equipment specifications, for calculation of air quantities necessary for cooling, ventilation, and for calculation of heat transmission losses or gains across exterior walls for the following structures: a) Diesel Generator Building b) Diesel Oil Transfer Building c) RAB Steam Tunnel d) Concrete Fan Enclosures above RAB Steam Tunnel e) Emergency Service Water Intake Structure These temperatures were used for equipment sizing, however, extreme temperatures may exceed these values without compromising plant operability.	Summer 105°F DB Winter -2°F DB

Table 9.4.0-1 (Continued)

2- INDOOR SPACE DESIGN TEMPERATURES AND HUMIDITIES DURING NORMAL PLANT OPERATION

		Maximum (3)		Minimum (2, 3)
	BUILDING OR AREA	DB (F)	RH% (1)	DB (F)
	REACTOR AUX. BLDG.			
1)	Access Aisles, Stairs, H&V Equipment Rooms Demineralizer Service Area Sample Room	90	-	60
2)	Sampling Rooms, Decontamination Areas	95	-	60
3)	Area of Low Potential Radiation and Containing Electrical Equipment such as Mech. and Elec. penetration area containment spray pump, etc.	104	-	60
4)	Area of High Potential Radiation and do not contain Electrical Equipment such as RHR Heat Exch. Area Seal Water Heat Exch. Area	122	-	60
5)	Steam Tunnel	122		47
5a)	Steam Tunnel Fan Enclosure	105		-2
6)	Control Room Areas	75	40	72
7)	Switchgear Room Areas:			
	General Areas	88	-	60
	Battery Rooms (4)	85	-	70
	H&V Equipment Rooms	104	-	60
	Rod Control Cabinets Room	80	-	60
	PIC Rooms	85	-	65
8)	Equipment Protection Room Areas:			
	General Areas	80	40	72
	H&V Equipment Room #7	87		54
	H&V Equipment Room #8	75	-	69
	REACTOR AUX. BLDG. (continued)			
9)	Pipe Tunnel El. 254 ft.	122	-	60
10)	Computer & Communication Complex:			
	Computer Room	77	55	72
	Communication Room	77	55	72
	H&V Equipment Room	75	-	60
	Battery Room	75	-	77
	FUEL HANDLING BUILDING			
1)	Upper Level Operating FL. El. 286 ft.	104	60	60
2)	Lower Level Operating FL. El. 236 ft.	104	190	60
	CONTAINMENT BUILDING	120	-	120
	WASTE PROCESSING BLDG:			
1)	Offices Personnel Handling Areas Laboratories Laundry Areas I&C Shop	75	50	72
2)	Access aisles Stairs	80	-	60
3)	Areas of Low Potential Radiation and Containing Electrical Equipment such as H&V Equipment Rooms, Tank and Filter Areas, Valve Gallery	104	-	60
4)	Areas of High Potential Radiation and do not contain Electrical Equipment such as waste evaporator concentrator and pipe tunnel areas, etc.	122	-	60
	TURBINE BLDG.:			
1)	Corridor Areas, Control Panel Area, Sampling Area	95	-	60
2)	Condensate Polishing Demineralizer and Tank Areas	120		60
3)	Electrical Equipment & Battery Room	105	-	60
	General Services Switchgear Room & Cable Spreading Room	104	-	60

2- INDOOR SPACE DESIGN TEMPERATURES AND HUMIDITIES DURING NORMAL PLANT OPERATION

		Maximum (3)		Minimum (2, 3)
	BUILDING OR AREA	DB (F)	RH% (1)	DB (F)
4)	Decontamination Facility	75	-	75
	DIESEL GENERATOR BUILDING.			
1)	Diesel Generator Room	120		51
2)	H&V Equipment Room and Exhaust Silencer Space	122		51
3)	Electrical Equipment Room	104		51
4)	Axial Fan Room	110		51
	FUEL OIL TRANSFER BUILDING	109		60
	EMERGENCY SERVICE WATER INTAKE STRUCTURE			
1)	Pump Room	122		51
2)	Electrical Equipment Room	116		51

NOTES TO TABLE 9.4.0-1

1) Humidity values indicated in this table represent the maximum design values.
2) Minimum temperature is given for plant shutdown conditions during winter when there is no internal heat. Temperatures are not limiting temperatures for equipment operability.
3) Maximum and Minimum values are the design values and do not include the tolerance inherent in the instruments and controls.
4) The maximum continuous operating temperature for the RAB Battery Rooms based on hydrogen generation and battery service life is 85°F. The summer design temperature used for HVAC cooling coil sizing is 77°F (summer battery room temperatures are lower than winter temperatures due to HVAC system design).

TABLE 9.4.0-2 PLANT AIRBORNE EFFLUENT RELEASE POINTS AND OUTSIDE AIR INTAKES[1]

POINT NO. RELEASE POINT OR O.A. INTAKE	RELEASE POINT ELEV. (FT MSL)	RELEASE POINT EL ABOVE GRADE[4] (FT)	DISTANCE TO NEAREST RESTRICTED AREA BOUNDARY [2] (FT)	BUILDING	UNIT NO.	SYSTEM	CFM[3] PER SYSTEM	CFM[3] TOTAL CFM PER POINT	SIZE & SHAPE OF ORIFICE	APPROX VELOCITY (FPM)
1 (Release Point)	352	92	435	Reactor Aux. Bldg.	1	Normal Exhaust Sys.	148000			
					1	NNS-Ventiliation Sys. (H.V. Equip. Room Vent. Subsystem – South)	27500			
					1	NNS Ventiliation Sys. (H.V. Equip. Rooms Vent Subsystem – North)	24500			
					1	Emergency Exhaust Sys.	(6800)			
						(Subtotal) $\sum_1$ =	200000			
				Fuel Handling Bldg.	1	Operating Floor Normal Exh. Sys.				
						(North)	44000			
						(South)	44000			
						Below Operating Floor Normal Exh. Sys.				
						(North)	51700			
						(South)	51700			
						Emergency Exh. Sys.	(6600)			
						(Subtotal) $\sum_2$ =	191400			
				Containment Bldg.	1	Normal Purge Exh. Sys.	1720[5]			
					1	Pre-Entry Purge Exh. Sys.	(37000)			
						(Subtotal) $\sum_3$ =	0			
1 (Release Point)	352	92	435	Reactor Aux. Bldg.	1	Control Room Purge Exhaust System	(13,050)			
1 (Release Point)	352	92	435	Reactor Aux. Bldg.	1	Switchgear Room Cable Spreading Room Smoke Purge System	(6,300)			
					1	Electrical Equipment Protection Rooms – Smoke Bridge System	(14,050)			
1 (Release Point)	352	92	435	Reactor Aux. Bldg.		$\sum_1 + \sum_2 + \sum_3$		391,400	Dia – 13 ft Circular	2950
3 (Release Point)	324	64	435	Turbine Bldg.	1	Combined Effluent from Condensate Polishers Cubicles and Mech. Vac. Pumps Effluent Treat. Sys.	22650	22650	Dia. 44 In. Circular	2360
3 (Release Point)	324	64	435	Turbine Bldg.	1	Turbine Building Decontamination Facility HVAC Sys.	4120	4120	Dia. 44 in. Circular	2360
						Smoke Purge System	(3600)	(3600)		
5 (Release Point)	341	81	335	Waste Processing Bldg.	1	Office Area Exhaustion	2700			
						Gen. Area. Exh. Fan	5500			
						Filter Exh. System	130800			
						Office Area Economizer Fan	16000			
						Cold Laundry Dryers	18000			
						Chiller Room Exhaust Fans	24400			
						Cold & Hot Laundry	9600			
						Control Room Smoke	(28000)			
						Exhausts (Sub Total)		207000	12 ft Circular	1830

TABLE 9.4.0-2 PLANT AIRBORNE EFFLUENT RELEASE POINTS AND OUTSIDE AIR INTAKES[1]

							CFM[3]			
POINT NO. RELEASE POINT OR O.A. INTAKE	RELEASE POINT ELEV. (FT MSL)	RELEASE POINT EL ABOVE GRADE[4] (FT)	DISTANCE TO NEAREST RESTRICTED AREA BOUNDARY [2] (FT)	BUILDING	UNIT NO.	SYSTEM	PER SYSTEM	TOTAL CFM PER POINT	SIZE & SHAPE OF ORIFICE	APPROX VELOCITY (FPM)
									Diameter	
5A (Release Point)	341	81	335	Waste Processing Bldg.	1	Laboratory Fume Hood Exhausts	27575			
						HVAC Equipment Room Exhaust Fans	25000			
						Switchgear Room Exhaust Fans	24500			
						Personnel Handling Exh. Fans	26500			
						(Sub Total)	103575		8 ft Circular	2061
6 (O.A. Intake)	317	57	490	Reactor Aux.	1	Control Room Fresh Air Intake – Purge Make-up	12590	12950	12 ft x 3 ft Rectangle	415
8 (O.A. Intake)	317	57	490	Reactor Aux. Bldg.	1	Control Room Fresh Air Intake – Normal Operation	1050	1050	12 ft x 3 ft Rectangle	417
11A (O.A. Intake)	317	57	490	Reactor Aux. Bldg.		Control Room Fresh Air Intake – Post Accident Operation	400	400	12 in x 12 in Rectangle	400
10 (O. A. Intake)	313	53	325	Tank Bldg.	1	Control Room Fresh Air Intake – Post-Accident Operation	400	400	Dia. 12 in. Circular	510
12 (Release Point)	317	57	475	Reactor Aux. Bldg.	1	Control Room Normal Exhaust System	1000	1000	Dia. 12 in. Circular	1273
11B (Release Point)	317	57	490	Reactor Aux. Bldg.	1	Operations Office Exhaust	500	500	18 in x 12 in Rectangle	333
11C (O.A. Intake)	316	56	490	Reactor Aux. Bldg.	1	Operations Office A/C	500	500	14 in x 10 in Rectangle	514
26(O.A. Intake)	271	11	65	Fuel Handling Bldg.	1	Normal Supply System (North)	46800	46800	6'-6 x 17'-6 Rectangle	411
27 (O.A. Intake)	286	36	520	WPB (Secondary)	1	Normal Supply System (South)	3500	3500	2 ft x 2ft, 2 ft x 2 ft Square	438
28 (O.A. Intake)	329	69	650	Fuel Handling Bldg.	1	Normal Supply System (Oper. Fl.)	40000			
						(Sub Total) $\sum_1$ =	40000			
				Reactor Aux. Bldg.	1	Non-Essential Supply System	26000		Rectangle 8 ft x 5 ft, 8 ft x 5ft, 10 ft x 5 ft	508
						(Sub Total) $\sum_2$ =	26000			
						$\sum_1 + \sum_2$ =	66000			
29 (O.A. Intake)	329	69	365	Fuel Handling Bldg.	1	Normal Supply Sys. (Oper. FL.)	40000			
						Sub Total =	40000			
				Reactor Aux. Bldg.	1	Non-Essential Supply System	26000		Rectangle 8 ft x 5 ft, 8 ft x 5 ft, 10 ft x 5 ft	508
						(Sub Total $\sum_2$ =	26000			
						$\sum_1 + \sum_2$ =	66000			
30 (O.A. Intake)	313	53	365	Reactor Aux. Bldg.	1	Normal Supply Sys.	137200	137200	17 ft x 10 ft, 10 ft x 7 ft, 5 ft x 7 ft Rectangle	500
36 (O.A. Intake)	305	45	450	Reactor Aux. Bldg.	1	Switchgear Room "A" Supply Sys.	3000	3000	2 ft x 2 ft square	750
Damper AC-D3SA-1 de-energized closed										

TABLE 9.4.0-2 PLANT AIRBORNE EFFLUENT RELEASE POINTS AND OUTSIDE AIR INTAKES[(1)]

POINT NO. RELEASE POINT OR O.A. INTAKE	RELEASE POINT ELEV. (FT MSL)	RELEASE POINT EL ABOVE GRADE[(4)] (FT)	DISTANCE TO NEAREST RESTRICTED AREA BOUNDARY [(2)] (FT)	BUILDING	UNIT NO.	SYSTEM	CFM[(3)] PER SYSTEM	CFM[(3)] TOTAL CFM PER POINT	SIZE & SHAPE OF ORIFICE	APPROX VELOCITY (FPM)
40 (O.A. Intake)	305	45	500	Reactor Aux. Bldg.	1	Switchgear Room “B” Supply Sys.	3000	3000	24 in x 20 in Rectangle	901
Damper AC-D5SB-1 de-energized closed										
44 (O.A. Intake)	324	64	465	Reactor Aux. Bldg.	1	Equipment Protection Rooms Supply Sys.	950	950	12 ft x 3 ft Rectangle	415
48 (Release Point)	305	45	450	Reactor Aux. Bldg.	1	Switchgear Room “A” Exhaust Sys.	3000	3000	20 in x 20 in Square	1080
52 (Release Point)	305	45	480	Reactor Aux. Bldg.	1	Switchgear Room “B” Exhaust Sys.	3000	3000	20 in x 20 in Square	1080
56 (Release Point)	324	64	450	Reactor Aux. Bldg.	1	Equipment Protection Rooms Exhaust Sys.	850	850	Dia = 12 in Circular	1083
60A (O.A. Intake)	263	3	65	Diesel Generator Bldg.	1A	Diesel Generator Room Ventilation Fresh Air Intake	42780		4’ x 26’-9 Rectangle	400
60B (O.A. Intake)	270	10	65	Diesel Generator Bldg.	1A	Diesel Generator Room Ventilation Fresh Air Intake	31620		4’ x 26’-9 Rectangle	296
60C (O.A. Intake)	292	32	65	Diesel Generator Bldg.	1A	Diesel Generator Room Ventilation Fresh Air Intake	70600		6 ft x 10 ft 6 ft x 10 ft Rectangle	588
60D (O.A. Intake)	270	10	65	Diesel Generator Bldg.	1A	Day Tank Room Ventilation Fresh Air Intake	1100		2 ft x 2 ft Square	275
61A (O.A. Intake)	263	3	65	Diesel Generator Bldg.	1B	Diesel Generator Room Ventilation Fresh Air Intake	42780		4’ x 26’-9 Rectangle	400
61B (O.A. Intake)	270	10	65	Diesel Generator Bldg.	1B	Diesel Generator Room Ventilation Fresh Air Intake	31620	31620	4’ x 26’-9 Rectangle	296
61C (O.A. Intake)	292	32	65	Diesel Generator Bldg.	1B	Diesel Generator Room Ventilation Fresh Air Intake	70600	70600	6 ft x 10 ft 6 ft x 10 ft Rectangle	588
61D (O.A. Intake)	270	10	65	Diesel Generator Bldg.	1B	Day Tank Room Ventilation Fresh Air Intake	1100	1100	2 ft x 2 ft Square	275
68A (Release Point)	312	52	65	Diesel Generator Bldg.	1A	Diesel Generator Room Ventilation Exhaust	57000	57000	54 in x 54 in. Square	2815
68B (Release Point)	312	52	65	Diesel Generator Bldg.	1A	Diesel Generator Room Ventilation Exhaust	57000	57000	54 in x 54 in. Square	2815
76 (Release Point)	312	52	65	Diesel Generator Bldg.	1A	Diesel Generator Exhaust & Day Tank Exhaust	29900	29900	6 ft x 10 ft Rectangle	498
69A (Release Point)	312	52	65	Diesel Generator Bldg.	1B	Diesel Generator Room Ventilation Exhaust	57000	57000	54 in x 54 in. Square	2815
69B (Release Point)	312	52	65	Diesel Generator Bldg.	1B	Diesel Generator Room Ventilation Exhaust	57000	57000	54 in x. 54 in. Square	2815
77 (Release Point)	312	52	65	Diesel Generator Bldg.	1B	Diesel Generator Exhaust & Day Tank Exhaust	29900	29900	6 ft x 10 ft Rectangle	498
84 (O.A. Intake)	300	40	485	Waste Processing Bldg.	1	Personnel Handling Facility HVAC System	27000		12 ft x 10 ft 12 ft x 10 ft Rectangle	509
						Office and Laundry Areas HVAC System (AH-41, AH-44, AH-65)	49000			
						Laboratory Areas HVAC System	18200			
						Control Room HVAC System	28000	122200		
85 (O.A. Intake)	300	40	500		1	Waste Processing Areas Ventilation System	184000			
						Laboratory Areas HVAC System	8885	192885	20 ft x 10 ft 20 ft x 10 ft Rectangle	482

TABLE 9.4.0-2 PLANT AIRBORNE EFFLUENT RELEASE POINTS AND OUTSIDE AIR INTAKES[1]

POINT NO. RELEASE POINT OR O.A. INTAKE	RELEASE POINT ELEV. (FT MSL)	RELEASE POINT EL ABOVE GRADE[4] (FT)	DISTANCE TO NEAREST RESTRICTED AREA BOUNDARY [2] (FT)	BUILDING	UNIT NO.	SYSTEM	CFM[3] PER SYSTEM	CFM[3] TOTAL CFM PER POINT	SIZE & SHAPE OF ORIFICE	APPROX VELOCITY (FPM)
86 (O.A. Intake)	286	26	650	Fuel Handling Bldg.	1	Normal Supply System (South)	47000	47000	8 ft x 6 ft 8 ft x 6 ft Rectangle	490
87 (O.A. Intake)	296	36	365	RAB	1	Containment Pre-entry Purge System	35000			
						Containment Vacuum Relief System	(32000)			
						Normal Containment Purge System	(1500)	35000*	10 ft x 7 ft Rectangle	500
91 (O.A. Intake)	296	36	565	RAB	1	Containment Vacuum Relief System	35000	35000	48 in. x 48 in. Square	2188
95 (Release Point)	305	45	550	RAB	1	Switchgear Rm “A” Exhaust	22150	22150	Dia-42” Circular	2302
96 (Release Point)	305	45	550	RAB	1	Switchgear Rm “B” Exhaust	18850	18850	Dia-42” Circular	1960
97 (Release Point)	324	64	550	RAB	1	Switchgear Rm “B” Rod Control Cabinet Rm Exhaust	5900	5900	Dia-24” Circular	1878
107 (O.A. Intake)	264.00’	4	100	Diesel Fuel Oil Transfer Pump Room	1A, B	Diesel Fuel Oil Transfer Pump Room Ventilation System	1300	2600	2’ x 4’ Rectangle	326
109 (Release Point)	264.00	4	100	Diesel Fuel Oil Transfer Pump Room	1A, B	Diesel Fuel Oil Transfer Pump Room Ventilation System	1300	2600	1’-6” x 4’ Rectangle	435
111 (O.A. Intake)	269’-6”	9’-6”	55	Emergency Service Water Intake Structure	1A	Emergency Service Water Intake Structure Pump Room Ventilation System	15000	15000	12’ 2 1/2 x 3’ Rectangle	410
112 (O.A. Intake)	269’-6”	9’-6”	55	Emergency Service Water Intake Structure	1B	Emergency Service Water Intake Structure Pump Room Ventilation System	15000	15000	11’-5 3/4 x 3’ Rectangle	435
115 (O.A. Intake)	273’	13’	55	Emergency Service Water Intake Structure	1A	Emergency Service Water Intake Structure Electrical Equipment Room HVAC System	9500	9500	5’ x 4’ Rectangle	475
117 (O.A. Intake)	273’	13’	55	Emergency Service Water Intake Structure	1B	Emergency Service Water Intake Structure Electrical Equipment Room HVAC System	9500	9500	5’ x 4’ Rectangle	475
123 (Release Point)	281	21	55	Emergency Service Water Intake Structure	1A	Emergency Service Water Intake Structure Pump Room Ventilation System	15000	15000	5’ x 5’ Rectangle	600
125 (Release Point)	281	21	55	Emergency Service Water Intake Structure	1A	Emergency Service Water Intake Structure Electrical Equipment Room HVAC System	9500	9500	5’ x 5’ Rectangle	380
127 (Release Point)	281	21	55	Emergency Service Water Intake Structure	1B	Emergency Service Water Intake Structure Pump Room Ventilation System	15000	15000	5’ x 5’ Rectangle	600
129 (Release Point)	281	21	55	Emergency Service Water Intake Structure	1B	Emergency Service Water Intake Structure Electrical Equipment Room HVAC System	9500	9500	5’ x 5’ Rectangle	380
139 (O.A. Intake)	334’ 4”	74’ 4”		RAB	1	Computer Room Complex	250	250	2x x2’	63
140 (O.A. Intake)	334’ 4”	74’ 4”		RAB	1	Computer Room Complex	15900	15900	6’ x 5’	530
141 (O.A. Intake)	334’ 3”	74’ 3”		RAB	1	Computer Room Complex	8300	8300	5’ x 3’ 6”	474
142 (O.A. Intake)	337’ 6”	77’ 6”		RAB	1	Computer Room Complex	0	0	2’ x 1’	75
143	335’	75’		RAB	1	Computer Room Complex	16000	16000	6’ x 5’	533

NOTES:

1) For all release points, except release point No. 1, the release temperature varies between 60°F (minimum) and 120°F (maximum).
For release point No. 1, the release temperature varies between 60°F (minimum), 112°F (maximum) during normal operation and 60°F (minimum), 142°F (maximum) during post-accident condition.

* Intake Points are sized for 35,000 cfm at any given time only one system required to operate.

2) For distances of plant airborne effluent release points to the exclusion boundary, see Figure 2.1.2-1
3) CFM given in parentheses are for emergency conditions and thus are not included in the CFM subtotals or totals.
4) Grade El 260 ft. MSL.
5) Air quantity shown is included in the RAB, Normal Exhaust System.

TABLE 9.4.1-1

DESIGN DATA FOR CONTROL ROOM AIR CONDITIONING SYSTEM COMPONENTS

A. Air Supply Units, Quantity	$2\ AH-15\ \begin{Bmatrix}(1A-SA)\\(1B-SB)\end{Bmatrix}$
1. Unit Fan Section	
Quantity, Total	1
Type	Centrifugal, Belt Driven
Air Flow, Per Fan, acfm	14,000
Code	Air Movement and Control Association (AMCA) Anti-Friction Bearing Manufacturers Association (AFBMA)
2. Motors	
Quantity, Total	1 per fan section
Type	20 Hp, 460 V, 60 Hz, 3 phase, Horizontal Induction Type
Insulation	Class H Type RH
Enclosure	TEFC
Code	NEMA, Class 1E
3. Cooling Coils	
Quantity, Total Banks	1 per unit
Type	Chilled water, finned tube
Material	Copper fin on copper tube steel headers
Code	ASME III, Code Class 3
4. Heating Coils	
Quantity, Total	1 per unit
Type	Electric
Capacity (kW) Per Coil	56
Code	Underwriters Laboratories (UL), National Electrical Manufacturers Association (NEMA), National Electric Code (NEC), Class 1E
5. Medium Efficiency Filters	
Quantity, Total Banks	1 per unit
Type	Extended media
Material	Glass fiber
B. Emergency Filtration Units, Quantity	2 R2 $\begin{Bmatrix}(1A-SA)\\(1B-SB)\end{Bmatrix}$
1. Fans	
Quantity, Total	1 per unit
Type	Centrifugal, single width, single inlet, direct drive
Air Flow, Per Fan , acfm (max)	4000
Code	Air Movement and Control Association (AMCA), Anti- Friction Bearing Manufacturer Association (AFBMA)

Table 9.4.1-1 (Continued)

2. Motors	
Quantity, Total	1 per fan
Type	25 Hp, 460 V, 60 Hz, 3 phase, Horizontal Induction Type
Insulation	Class H, Type RH
Enclosure and Ventilation	TEFC-XT
Code	NEMA, Class 1E
3. HEPA Filters	
Quantity, Total Banks	2 per unit
Cell size	24 in. high, 24 in. wide,11-1/2 in. deep
Max. resistance clean, in. wg.	1.0
Max. resistance loaded, in. wg.	2.0
Efficiency	99.97 percent when tested with 0.3 micron DOP
Material	Meets the requirements of ANSI/ASME N509-1980
4. Charcoal Adsorbers	
Type	Multiple gasketless bed cells in air-tight housing
Quantity, Total	1 per unit
Material	Impregnated coconut shell (Meeting the requirements of ANSI/ASME N509 1980, Table 5.1 with the exception that the 30°C/95% relative humidity methyl iodide test is done per ASTM D3803-1989)
Depth of bed (in.)	4 in.
Face velocity (fpm)	40
Average atmosphere residence time	0.25 seconds per 2 in. of adsorber bed
Adsorber capacity of iodine loading	2.5 mg of total iodine (radioactive plus stable) per gram of activated carbon
Efficiency:	
Elemental iodine	99% at 70% RH
Organic iodine	99% at 70% RH
Adsorbent Acceptance Inplace Leak Test Criteria (See Table 6.5.1-2)	Carbon Laboratory Acceptance Testing will be performed in accordance with, and will me the requirements of Position C.6 of R.G. 1.52, Revision 2, with the exceptions listed in Table 6.5.1-2. Adsorber Inplace Leak Testing will be performed in accordance with, and will meet the requirements of Position C.5.d of R.G. 1.52, Revision 2, with the exceptions listed in Table 6.5.1-2.
5 .Electric Heater	
Quantity	1 per unit
Capacity (kW) Per Coil	14 sufficiently sized to reduce the relative humidity of the inlet air from 100% to 70%
Code	Class IE

Table 9.4.1-1 (Continued)

6. Demister	
Quantity, Per Unit	1 bank
Air Flow acfm	4000
Max. resistance clean, in. wg.	1.05
Max. resistance loaded, in. wg.	2.0
Material	304 stainless steel casing and glass fiber mesh
C. Exhaust System, Quantity	1
1. Exhaust Fans (E-9) (1A and 1B)	
Type	Centrifugal
Quantity	2, One Standby
Capacity acfm Per Fan	1000
Motor HP	1
Motor Code	NNS
D. Purge Systems, Quantity	1
1. Purge Fans (ES-1) (1A and 1B)	
Type	Tubular Centrifugal High Temperature
Quantity	2, One Standby
Capacity acfm Per Fan	13,400
Motor HP	25
Motor Code	NNS

TABLE 9.4.1-2 CONTROL ROOM AIR CONDITIONING AND EMERGENCY FILTRATION SYSTEM (1) OPERATIONAL STATUS OF VALVES, DAMPERS, AND FANS AND CORRESPONDING AIR FLOW RATES

			NORMAL OPERATION		PURGE OPERATION (4)		CL_2 ACCIDENT (2) OPERATION		HI RAD. SYS. (2) OPERATION	
SYSTEMS	SIZE	VALVES DAMPERS FAN DESIGNATION	OPER. STAT (5)	AIR FLOW ACFM	OPER. STAT (5)	AIR FLOW ACFM	OPER. STAT (5)	AIR FLOW ACFM	OPER. STAT (5)	AIR FLOW ACFM
		AH-15 (1A-SA)	R	14000	R	14000	R	14000	R	14000
SUPPLY		CZ-D1SA-1	O	14000	O	14000	O	14000	O	14000
	36”	3CZ-B25SA-1	O	14000	O	14000	O	14000	O	14000
		AH-15 (1B-SB)	S		S		S		S	
		CZ-D2SB-1	C		C		C		C	
	36”	3CZ-B26SB-1	C		C		C		C	
O.A.I		CZ-Z1SN-1	O	1050	O	1050	O		O	
NORMAL	16”	3CZ-B1SA-1	O	1050	O	1050	C		C	
	16”	3CZ-B2SB-1	O	1050	O	1050	C		C	
O.A.I	36”	3CZ-B17SA-1	C		O	12950	C		C	
PURGE	36”	3CZ-B18SB-1	C		O	12950	C		C	
RETURN		CZ-D69SA-1	O	12950	C		O	14000	O	14000
NORMAL		CZ-D70SB-1	C		C		C		C	
		E-9 (1A-NNS)	R	1000 (max.)	R	1000	I		I	
		CZ-D6-1	O	1000 (max.)	O	1000	C		C	
EXHAUST		CZ-D12-1	M	1000 (max.)	O	1000	C		C	
		E-9 (1B-NNS)	S		S		I		I	
		CZ-D7-1	C		C		C		C	
		CZ-D13-1	C		C		C		C	
		CZ-X2SN-1	O	1000 (max.)	O	1000	O		O	
	12”	3CZ-B3SA-1	O	1000 (max.)	O	1000	C		C	
	12”	3CZ-B4SB-1	O	1000 (max.)	O	1000	C		C	
RETURN		CZ-D66SA-1	C		C		O	1050	O	1050
POST-LOCA		CZ-D61SB-1	C		C		C		C	

TABLE 9.4.1-2 CONTROL ROOM AIR CONDITIONING AND EMERGENCY FILTRATION SYSTEM (1) OPERATIONAL STATUS OF VALVES, DAMPERS, AND FANS AND CORRESPONDING AIR FLOW RATES

			NORMAL OPERATION		PURGE OPERATION (4)		CL_2 ACCIDENT (2) OPERATION		HI RAD. SYS. (2) OPERATION	
SYSTEMS	SIZE	VALVES DAMPERS FAN DESIGNATION	OPER. STAT (5)	AIR FLOW ACFM	OPER. STAT (5)	AIR FLOW ACFM	OPER. STAT (5)	AIR FLOW ACFM	OPER. STAT (5)	AIR FLOW ACFM
		ES-1 (1A-NNS)	I		R	13400	I		I	
	30”	3CZ-B13SA-1	C		O	13400	C		C	
PURGE	30”	3CZ-B14SB-1	C		O		C		C	
		ES-1 (1B-NNS)	I		S		I		I	
O.A.I	12”	3CZ-B9SA-1	C		C		C		O	400 (max)
POST ACC.	12”	3CZ-B11SA-1	C		C		C		C	
	12”	3CZ-B10SB-1	C		C		C		O	400 (max)
	12”	3CZ-B12SB-1	C		C		C		C	
EMERGENCY		3CZ-V1SA-1	C		C		C		O	400 (max)
SUPPLY		3CZ-V2SB-1	C		C		C		O	400 (max)
		R-2 (1A-SA)	I		I		R		R	4000
	20”	3CZ-B23SA-1	C		C		O		O	4000
EMERGENCY	20”	3CZ-B21SA-1	C		C		O		O	4000
FILTRATION	20”	3CZ-B19SA-1	C		C		O		O	4000
		R-2 (1B-SB)	I		I		S(3)		S(3)	
	20”	3CZ-B24SB-1	C		C		C		C	
	20”	3CZ-B22SB-1	C		C		C		C	
	20”	3CZ-B20SB-1	C		C		C		C	
	20”*	3CZ-B27SAB-1	O	0	O	0	O	4000	O	3600 (min)

* PARTIALLY OPEN FOR BALANCING

Table 9.4.1-2 (Continued)

NOTES TO TABLE 9.4.1-2

1) The table represents supplementary information to Figure 9.4.1-1.

2) Post-accident operation represents the operational status of the system under operator control.

   a. Depending on the reading of radiation monitors located at both air intakes, during the radiological accident the control room operator will manually remotely, open the selected air intake by setting the air intake isolation valves and allowing a maximum of 400 cfm of the outside air into the control room envelope for pressurization.

   b. All isolation valves in the post-accident outside air intakes will have leak-tight closing and variable setting capability.

3) After automatic start-up of both emergency filtration systems, one out of the two will be manually de-energized and placed on standby.

4) Purge operation represents the operational status of the system under operator control.

5) The notations used to designate the operational status of the tabulated components are:

Notation	Operational Status
S	Standby
R	Running (operating)
O	Open
C	Closed
M	Modulating
I	Inactive
(+) or (-)	Positive pressure (+) or Negative pressure (-) in the control room envelope.

TABLE 9.4.1-4 CONTROL ROOM AIR CONDITIONING SYSTEM SINGLE FAILURE ANALYSIS

COMPONENT IDENTIFICATION	FAILURE MODE	EFFECT ON SYSTEM	METHOD OF DETECTION	MONITOR	REMARKS
Normal Outside Air Intake and Exhaust Valve	Loss of power-fails to close on initiation of recirc. phase	Uncontrolled contaminated air enters Control Room	Valve position switch alarms	CRI	Redundant standby valve powered by alternate sources will be operable to isolate Control Room.
Post-Accident Outside Air Intake Valve	Loss of Power-Fails to Open	Prevent controlled pressurization	Power Failure Indicator	CRI	Operator manually hand wheel opens affected valve
	One Valve Freezes Closed	Prevent controlled pressurization	Valve Position switch alarm	CRI	Redundant standby intake is available.
Supply Filter	Clogs	Reduction of supply air flow	1) Air flow switch at fan discharge	CRI	1) Redundant capacity standby unit is operable powered by alternate source.
			2) Temp. indicating controller		2) Filters are accessible for replacement
Cooling Coil	Fails	Change in supply air temp.	Temp. indicating controller with sensor at unit discharge	CRI	Redundant capacity standby unit is operable powered by alternate source.
Supply Fan	Fails	Loss of supply air	Power Failure Indicator	CRI	Redundant capacity standby unit is operable powered by alternate source.
Supply Unit Isolation Valve and Dampers	Fails to open	Loss of supply air	Flow switch at fan discharge	CRI	Redundant Supply Unit is operable powered by alternate source.
Zone Reheat Coil & Electric Heating Coil	Fails to automatically shut off	Increase in zone space temperature	Temp. indicating controller	CRI	Coil can be manually shut off at local control panel in Control Room area.
Emergency Filter Booster Fan	Fails	Loss of air flow through filter system	Flow switch at system discharge	CRI	Redundant capacity standby unit is operable powered by alternate source.
Isolation Valve at Emergency Filter Train	Fails to open	Loss of air flow through filter system	Flow switch at system discharge	CRI	Redundant capacity standby unit is operable powered by alternate source.
Emergency Filter Train	Clogs	Reduction of air flow through filter system	Flow switch at system discharge	CRI	Redundant capacity standby unit is operable powered by alternate source
Water Chiller	Fails	Loss of Cooling capacity	1) Temp. indicating controller with sensor at supply fan discharge.	CRI	Redundant capacity standby unit is operable powered by alternate source.
			2) Water temp. indicator with sensor at chiller discharge	CRI	100% capacity standby system is is operable powered by alternate source.
Chilled Water Pump	Fails	Loss of chilled water flow	Flow switch at pump discharge	CRI	100% capacity standby system is operable powered by alternate power source.
Smoke Purge Air Make-up or Exhaust Valves	1. Opens inadvert.	Loss of Isolation Uncontrolled Cont. Air Enters Control	Valve position indicators	CRI	Redundant standby valves will assure the continued Iso. of the Control Room.

TABLE 9.4.1-4 CONTROL ROOM AIR CONDITIONING SYSTEM SINGLE FAILURE ANALYSIS

COMPONENT IDENTIFICATION	FAILURE MODE	EFFECT ON SYSTEM	METHOD OF DETECTION	MONITOR	REMARKS
		Room			
NORMAL AND OFFSITE POWER FAILS					
Diesel Gen. to which Control Room equipment is connected.	Fails	Loss of: 1) one Control Room A/C System 2) One emergency filter system.	DG malfunction alarm, flow switch at fan discharge, flow switch in chilled water system.	CRI	1) Standby A/C System operable 2) Standby emergency filter system is operable.

TABLE 9.4.2-1

DESIGN DATA FOR FUEL HANDLING BUILDING HEATING VENTILATING AND AIR CONDITIONING SYSTEM

A. AIR CONDITIONING SYSTEM FOR OPERATING FLOOR

a. Normal Supply System	
Quantity	Four Identical Units
Each unit contains the following:	
1. Air Handling Unit Fan Section	
Quantity	1
Type	Centrifugal, Belt Driven
Air Flow, Each Fan, acfm	20,000
Code	Air Movement and Control Association (AMCA) Anti-Friction Bearing Manufacturers Association (AFBMA)
2. Motors	
Quantity, Per Fan	1
Type	40 hp, 460 volts, 60 Hz 3 phase, Induction Type
Insulation	Class B, Powerhouse
Enclosure	Drip-proof
Code	NEMA, Class B
3. Reheat Coil	
Quantity, Total	1
Type	Electric
Capacity (KW)	65
Code	Underwriters Laboratories (UL), National Electrical Manufacturers Association (NEMA) National Electric Code (NEC)
4. Cooling Coils	
Quantity, Total	1
Type	Chilled water finned tube
Material	Copper fin on copper tube steel headers
5. Heating Coil	
Quantity, Total	1
Type	Electric
Capacity (KW)	375
Code	Underwriters Laboratories (UL) National Electrical Manufacturers Association (NEMA), National Electric Code (NEC)
6. Medium Efficiency Filters	
Quantity, Per System	One Bank
Type	Extended Medium
Material	Synthetic or Fiberglass

Table 9.4.1-2 (Continued)

b. NORMAL EXHAUST SYSTEM	
Quantity	Two Identical Units
Each unit contains the following:	
1. Exhaust Fans	
Quantity	2
Type	Centrifugal, Belt Driven
Air Flow, Per Fan acfm	22,000
Code	Air Movement and Control Association (AMCA), Anti-Friction Bearing) Manufacturers Association (AFBMA)
2. Exhaust Fan Motors	
Quantity, Per Fan	1
Type	40 Hp (E-23,25 & 26), 50 HP (E-24) 460 V 60 Hz, 3 phase, Induction Type
Insulation	Class B Powerhouse
Enclosure	Open Drip-proof
Code	NEMA, Class B
c. DECONTAMINATION ENCLOSURE EXHAUST FAN	
1. Fan	
Quantity	1
Type	Centrifugal, Belt Driven
Air Flow, Per Fan acfm	7,000
Code	Air Movement and Control Association (AMCA), Anti-Friction Bearing Manufacturers Association (AFBMA)
2. Fan Motors	
Quantity, Per Fan	1
Type	7 1/2 Hp, 460 V, 60 Hz, 3 Phase, Induction Type
Insulation	Class B
Enclosure	Open Drip-proof
Code	NEMA

Table 9.4.1-2 (Continued)

B. <u>VENTILATION SYSTEM FOR SPACES BELOW OPERATING FLOOR</u>

a. NORMAL SUPPLY SYSTEM (North & South)

Quantity	Two Identical Units
Each unit contains the following:	
1. <u>Air Handling Unit Fan Section</u>	
Quantity	2 (one standby)
Type	Vaneaxial, Belt Driven
Air Flow, Per Fan, acfm	50,700 (AH-21), 50,500 (AH-22)
Code	Air Movement and Control Association (AMCA) Anti-Friction Bearing Manufacturers Association (AFBMA)
2. <u>Motors</u>	
Quantity Per Fan	1
Type	100 hp, 460 volts, 60 Hz, 3 ph Induction Type
Insulation	Class F
Enclosure	Open DRP Proof
Code	NEMA
3. <u>Heating Oil</u>	
Quantity, per unit	1
Type	Electric
Capacity (KW)	732
Code	UL, NEMA, NEC
4. <u>Medium Efficiency Filters</u>	
Quantity, per unit	One bank
Type	Extended Medium
Material	Synthetic or Fiberglass

b. NORMAL EXHAUST SYSTEM (North & South)

Quantity Two Identical Units

Each unit contains the following:

1. <u>Exhaust Fans</u>	
Quantity	2 (one standby)
Type	Centrifugal; Belt Driven
Air Flow, Per Fan, acfm	51,700
Code	Air Movement and Control Association (AMCA), Anti-Friction Bearing Manufacturers Association (AFBMA)
2. <u>Exhaust Fan Motors</u>	
Quantity, Per Fan	1
Type	125 HP, 460 V, 60 Hz, 3 phase, Induction Type
Insulation	Class B, Powerhouse
Enclosure	Drip-proof
Code	NEMA, Class B

c. NORTH HEATING & VENTILATING EQUIPMENT ROOM

1. <u>Unit Heater</u>	
Quantity	1
Type	Electric 460V, 3 Phase, 60 Hz
Capacity (KW)	15
Code	Underwriters Laboratory (UL), National Electric Manufacturers Association (NEMA), National Electric Code NEC

Table 9.4.1-2 (Continued)

2. <u>Exhaust Fan</u>	
Quantity	1
Type	Propeller
Air Flow, acfm	3,200
Code	Air Movement and Control Association (AMCA) Anti-Friction Bearing Manufacturers Association (AFBMA)
3. <u>Exhaust Motor</u>	
Quantity	1
Type	3/4 HP, 460 V, 60 Hz, 3 Phase, Induction Type
Enclosure	TEFC
Code	National Electrical Manufacturers Association (NEMA), National Electric Code (NEC)
Insulation	Class B
C. <u>EMERGENCY EXHAUST SYSTEM</u>	
See TABLE 6.5.1-1	
D. <u>THE SPENT FUEL POOL PUMP VENTILATION SYSTEM</u>	
Quantity	Two Identical Units
Each unit contains the following:	
1. <u>Air Handling Unit Fan Section</u>	
Quantity	1
Type	Centrifugal, Belt Driven
Air Flow, Each Fan, acfm	19,800
Code	Air Movement and Control Association (AMCA) Anti-Friction Bearing Manufacturers Association (AFBMA)
2. <u>Motors</u>	
Quantity, Per Fan	1
Type	20 Hp, 460 V, 60 Hz 3 phase, Induction Type
Enclosure	TEFC/XT
Code	NEMA, Class IE
Insulation	Class H
3. <u>Cooling Units</u>	
Quantity, Total	1
Type	Chilled water finned tube
Material	Copper fin or copper tube, steel headers
Code	ASME III, Code Class 3
4. <u>Medium Efficiency Filters</u>	
Quantity, Per System	One Bank
Type	Extended Medium
Material	Glass Fiber

TABLE 9.4.2-2

SPENT FUEL POOL PUMP ROOM VENTILATION SYSTEM SINGLE FAILURE ANALYSIS

COMPONENT IDENTIFICATION AND QUANTITY	FAILURE MODE	EFFECT ON SYSTEM	METHOD OF DETECTION	MONITOR	REMARKS
Fans (two)	Fails to Operate	Loss of Cooling Air for Spent Fuel Pool Pumps and Heat Exchanger area	Low Flow Alarm	C.R.I**	100% capacity stand-by unit provided
Motorized Damper (two)	Fails to open	Loss of Supply Air	Flow Alarm	C.R.I.	100% capacity stand-by unit provided
Motorized Damper (two)	Fails to Close During Single Failure	None			Gravity damper remains closed
Filter	Clogs	Air Flow Reduction	Low Flow Alarm	C.R.I.	100% capacity stand-by unit provided
Cooling Coil	Fails to Operate	Air Temperature Rise	High Temperature Alarm	C.R.I.	100% capacity stand-by unit provided
Diesel Generator	Fails to Function	Air Handling Unit Fails to Run	Diesel Generator Malfunction Alarm	C.R.I.	100% capacity stand-by unit provided

**CONTROL ROOM INDICATION

TABLE 9.4.3-1

DESIGN DATA FOR REACTOR AUXILIARY BUILDING
HVAC SYSTEM COMPONENTS

A. NORMAL VENTILATION SYSTEM

1. Supply Fans	
Quantity, Total	2, (1 Stand-By)
Type	Type S, adjustax vane axial, direct drive
Air Flow, Per Fan, CFM	132,000
Code	Air Movement and Control Association (AMCA) Anti-Friction Bearing Manufacturers Association (AFBMA)
2. Supply Fan Motors	
Quantity, per fan	1
Type	250 HP, 460 V, 60 Hz, 3 phase Horizontal Induction Type
Insulation	Class H
Enclosure	TEAO/XT
Code	NEMA
3. Air Washer Section	
Quantity, Total	1
Type	Cellulosic fill type
Air Flow (CFM)	132,000
4. Heating Coil	
Quantity, Total	1
Type	Electric
Capacity (KW)	2100
Code	Underwriters Laboratories (UL), National Electrical Manufacturers Association (NEMA), National Electric Code (NEC)
5. Medium Efficiency Filter	
Quantity, Total	1
Type	Extended media
Material	Synthetic or Fiberglass
6. Exhaust Fans	
Quantity, Total	4, 25% capacity each
Type	Centrifugal with variable inlet vanes, single width, single inlet, direct drive
Air Flow, Per Fan, acfm	37,000
Code	Air Movement and Control Association (AMCA), Anti-Friction Bearing Manufacturer Association (AFBMA)
7. Exhaust Fan Motors	
Quantity, Per Fan	1
Type	150 Hp, 460 V, 60 Hz, 3 phase, Horizontal Induction Type
Insulation	Class H
Enclosure and Ventilation	Drip-proof
Code	NEMA
8. Medium Efficiency Filters	
Quantity, Total	4 Banks
Type	Extended media
Material	Synthetic or Fiberglass

Table 9.4.3-1 (Continued)

9. HEPA Filters	
Quantity, Total	4 Banks
Cell Size	24 in. high, 24 in. wide, 11 1/2 in. deep
Max. Resistance Clean, in. wg.	1.0
Max. Resistance Loaded, in. wg.	2.0
Efficiency	99.97% when tested with 0.3 micron DOP
Material	Meets the requirements of ANSI/ASME N509-1980
10. Charcoal Adsorbers	
Type	Multiple gasketless bed cells in airtight housing
Quantity, Total	4 Banks: 4: depth of bed
Media	Impregnated coconut shell
Efficiency	
New Activated Carbonper 2 inch bed depth except as noted	At least 99.9% of molecular iodine and at least 97% of methyl iodide when tested at 30°C and 95% relative humidity. At least 99% of methyl iodide when tested at 80°C and 95% relative humidity. At least 98% of methyl iodide when tested at 130°C and 95% relative humidity. At least 99.5% of molecular iodine per 1 inch bed depth when tested at 180°C.
Lab Test for Representative Samples of Used Carbon (18 month test requirement)	At least 90% of methyl iodide when tested at 30°C and 70% relative humidity.
Face velocity (fpm)	40

B. EMERGENCY EXHAUST SYSTEM

See Table 6.5.1-3

C. RAB-NNS VENTILATION SYSTEM

a) H&V Equipment Room System (AH-14 and AH-14Z)

1. Supply Fan	
Quantity, Total	2
Type	Centrifugal, single width, single inlet, Belt Driven
Air Flow, CFM Each	26000
Code	Air Movement and Control Association (AMCA), Anti-Friction Bearing Manufacturers Association (AFBMA)
2. Supply Fan Motors	
Quantity, Total	2
Type, each	30 Hp, 460 V, 60 Hz 3 phase
Insulation	Class F
Enclosure	Open Drip-proof
Code	NEMA
3. Medium Efficiency Filter	
Quantity, Total	1 Bank each
Type	Extended media
Material	Synthetic or Fiberglass
4. Heating Coil	
Quantity, Total	1 each
Type	Electric
Capacity (KW), each	200

Table 9.4.3-1 (Continued)

Code	Underwriters Laboratories (UL), National Electrical Manufacturers Association (NEMA), National Electric Code (NEC)
5. Cooling Coil	
Quantity, Total	1 each
Type	Chilled water, finned tube
Material	Copper fins on copper tube water box
6. Return Fan	
Quantity	1 each
Type	Centrifugal, Belt Driven
Air Flow, ACFM	26,000 CFM
7. Return Fan Motor	
Quantity	1 each
Type	40 Hp, 460 V, 60 Hz 3 phase, horizontal induction type
Insulation	Class F
Enclosure	Open Drip-proof
Code	NEMA
b) Non-Essential Fan Coolers (AH-30, AH-63 and AH-63Z)	
1. Air Handling Unit	
Fan Section	
Quantity	3
Type	Centrifugal, Belt Driven
Air Flow, Per Fan, CFM	5500 (AH-30 CVCS Chillers and pumps), 6500 (AH-63Z480 V. Aux. Bus 1-4B1 Area)
Code	Air Movement and Control Association (AMCA), Anti-Friction Bearing Manufacturers Association (AFBMA)
2. Motors	
Quantity, Per Fan	1
Type	5 Hp, 460 V, 60 Hz 3 phase
Insulation	Class B Powerhouse
Enclosure	Open Drip-proof
Code	NEMA, Class B
3. Cooling Coils	
Quantity, Per Air Handling Unit	1
Type	Chilled water, finned tube
Material	Copper fins on copper tube
4. Medium Efficiency Filter	
Quantity, Per Unit	1 Bank
Type	Extended media
Material	Synthetic or Fiberglass

TABLE 9.4.3-2

DESIGN DATA FOR WASTE PROCESSING AREAS VENTILATION SYSTEM

a) Supply System	
Quantity	Two Identical Units
Each Unit contains the following:	
1. Supply Fans	
Quantity	2 (1 Stand-by)
Type	Vaneaxial, Direct Drive
Air Flow, Each Fan, acfm	92,000
Code	Air Movement and Control Association (AMCA), Anti-Friction Bearing Manufacturers Association (AFBMA)
2. Supply Fan Motors	
Quantity, per fan	1
Type	150 HP, 460 V, 60 Hz, 3 phase, Induction Type
Insulation	Class B
Enclosure	TEAO
Code	NEMA
3. Air Washer Section	
Quantity, Total	1
Type	Cellulosic Fill Type
Air Flow (acfm)	92,000
4. Heating Coil	
Quantity, Total	1
Type	Electric
Capacity (KW)	1400
Code	Underwriters Laboratories (UL), National Electrical Manufacturers Association (NEMA), National Electric Code (NEC)
5. Medium Efficiency Filter	
Quantity, Total	1 Bank
Type	Extended Media
Material	Synthetic or Fiberglass
6. Cooling Coil Unit (AH-91)	
Quantity, Total	1
Type	Chilled Water Finned Tube
Material	Copper Fins on Copper Tube
ACFM:	15,150
b) FAN COOLERS	
1. Supply Fans	
Quantity, Total	Nine
Type	Centrifugal, Belt Driven
Air Flow, acfm	Four fans at 13,000 each (AH 70,71,72,73) Four fans at 5,000 each (AH-75,79,80,77) One fan at 7,000 (AH-74)
Code	Air Movement and Control Association (AMCA), Anti-Friction Bearing Manufacturers Association (AFBMA)
Quantity, Total	10
Type	(4) Units at 15 HP (AH-70,71,72&73) (5) Units at 5 HP (AH-77,78,79,80,75) (1) Unit at 7-1/2 HP (AH-74) 460 V, 60 Hz, 3 phase

Table 9.4.3-2 (Continued)

	Induction type
Insulation	Class B, Powerhouse
Enclosure	Open Drip-proof
Code	NEMA - Class B
2. Cooling Coils	
Quantity, Total	10
Type	Chilled water finned tube
Material	Copper fin on copper tube
3. Medium Efficiency Filter	
Quantity, Per Unit	1 Bank
Type	Extended Media
Material	Synthetic or Fiberglass
c) FILTERED EXHAUST SYSTEM	
Quantity	Four Identical Units
Each unit contains the following:	
1. Exhaust Fans	
Quantity	1 per unit, and 1 standby fan (Total of 5)
Type	Centrifugal with variable inlet vanes, single width, single inlet, direct drive (belt drive on standby fan)
Air Flow, Per Fan, acfm	49,333
Code	Air Movement and Control Association (AMCA), Anti-Friction Bearing Manufacturer Association (AFBMA)
2. Exhaust Fan Motors	
Quantity, Per Fan	1
Type	150 HP (100 Hp on standby fan), 460 V, 60 Hz, 3 phase, Induction Type
Insulation	Class H
Enclosure	Drip-proof Guarded
Code	NEMA
3. Charcoal Adsorbers	
Type	Impregnated
Bed Thickness	4" depth of bed
New Activated Carbon (per 2 inch bed depth except as noted)	At least 99.9% of molecular iodine and at least 97% of methyl iodide when tested at 30°C and 95% relative humidity. At least 99% of methyl iodide when tested at 80°C and 95% relative humidity. At least 98% of methyl iodide when tested at 130°C and 95% relative humidity. At least 99.5% of molecular iodine per 1 inch bed depth when tested at 180°C.
Lab Test for Representative Samples of Used Carbon (18 month test requirement)	At least 90% of methyl iodide when tested at 30°C and 70% relative humidity.
Material	Impregnated, activated coconut shell charcoal. Material in contact with charcoal shall be 304 stainless steel ASTM A240
Face Velocity (fpm)	40
4. HEPA Filters	
Quantity, Per System	1 Bank
Cell (Unit) Size	24" Hx24" Wx11-1/2" deep
Max resistance clean, loaded, in. wg.	1.0
Max resistance loaded, in. wg.	2.0

Table 9.4.3-2 (Continued)

Efficiency	99.97 percent when tested with 0.3 micron Dioctylphtalate smoke
Material	Meets the requirements of ANSI/ASME N509-1980
5. Prefilters	
Quantity, Per System	1 Bank
Type	Medium efficiency extended media
Material	Synthetic of Fiberglass
d) EXHAUST SYSTEM	
Quantity	Three Units
Each system contains the following:	
1. Exhaust Fans	
Quantity, per system	2 (one stand-by)
Type	Centrifugal Belt Driven
Air Flow, Per Fan acfm	26,800 (R-7) 27,000 (R-8) 27,500 (E-59)
Code	Air Movement and Control Association (AMCA), Anti-Friction Bearing Manufacturers Association (AFBMA)
2. Exhaust Fan Motors	
Quantity, Per Fan	1
Capacity, Hp	40 (R-7) 60 (R-8) 30 (E-59) 460 V, 60 Hz, 3 phase, Induction Type
Insulation	Class F (R-8)
Enclosure	Open Drip-proof
Code	NEMA

TABLE 9.4.3-3

DESIGN DATA FOR WPB CONTROL ROOM HVAC SYSTEM

Quantity	Two Identical Systems
Each system contains the following:	
1. Supply Fan	
Quantity	1
Type	Centrifugal, Belt Driven
Air Flow, Each Fan, acfm	14,000
Code	Air Movement and Control Association (AMCA), Anti-Friction Bearing Manufacturers Association (AFBMA)
2. Supply Fan Motors	
Quantity, Per Fan	1
Type	30 Hp, 460 V, 60 Hz, 3 phase Induction Type
Insulation	Class F
Enclosure	Open Drip-proof
Code	NEMA
3. Reheat Coil	
Quantity	1
Type	Electric
Capacity (KW)	80
Code	Underwriters Laboratories (UL), National Electrical Manufacturers Association (NEMA), National Electric Code (NEC)
4. Cooling Coils	
Quantity	1
Type	Chilled water finned tube
Material	Copper fin or copper tube
5. Heating Coil	
Quantity	1
Type	Electric
Capacity (KW)	196
Code	Underwriters Laboratories (UL) National Electrical Manufacturers Association (NEMA), National Electric Code (NEC)
6. Medium Efficiency Filters	
Quantity	One Bank
Type	Extended Media
Material	Synthetic or Fiberglass
7. Purge Fans	
Quantity	2
Capacity (acfm) per fan	14,000
Motor Hp	20

TABLE 9.4.3-4

DESIGN DATA FOR WPB PERSONNEL HANDLING FACILITY HVAC SYSTEM

a) NORMAL SUPPLY SYSTEM	
1. Supply Fan (AH-42)	
Quantity, Total	1
Type	Centrifugal, Belt Driven
Air Flow, Each Fan, acfm	27,000
Code	Air Movement and Control Association (AMCA), Anti-Friction Bearing Manufacturers Association (AFBMA)
2. Motors	
Quantity, Per Fan	1
Type	40 Hp, 460 V, 60 Hz, 3 phase, Induction Type
Insulation	Class F
Enclosure	Open Drip-proof
Code	NEMA
3. Cooling Coils	
Quantity, Total	1
Type	Chilled water finned tube
Material	Copper fin on copper tube
4. Heating Coil	
Quantity, Total	1
Type	Electric
Capacity (KW)	378
Code	Underwriters Laboratories (UL) National Electrical Manufacturers Association (NEMA), National Electric Code (NEC)
5. Medium Efficiency Filters	
Quantity, Total	One Bank
Type	Extended Medium
Material	Synthetic or Fiberglass
b) REHEAT COILS (In the Supply Ducts)	
Quantity, Total	6: EHC-53,54,75,76,77,78
Type	Electric
Capacity (KW)	38.2,40,30,31,10 and 25, respectively
Code	Underwriters Laboratories (UL) National Electrical Manufacturers Association (NEMA), National Electric Code (NEC)
c) NORMAL EXHAUST SYSTEM	
1. Exhaust Fans	
Quantity	1
Type	Centrifugal, Belt Driven
Air Flow, Per Fan, acfm	26,500
Code	Air Movement and Control Association (AMCA), Anti-Friction Bearing Manufacturers Association (AFBMA)
2. Exhaust Fan Motor	
Quantity, Per Fan	1
Type	40 HP, 460 V, 60 Hz, 3 phase, Induction Type
Insulation	Class B
Enclosure	Drip-proof
Code	NEMA

TABLE 9.4.3-5

DESIGN DATA FOR WPB OFFICE AND LAUNDRY AREAS HVAC SYSTEM

a)	NORMAL SUPPLY SYSTEM (Laundry)	
1.	Supply Fan	
	Quantity, Total	6
	Type	Centrifugal, Belt Driven
	Air Flow, Each Fan, acfm	3000
	Code	Air Movement and Control Association (AMCA), Anti-Friction Bearing Manufacturers Association (AFBMA)
2.	Motors	
	Quantity, Total 6	
	Type, Each Fan	5 Hp, 460 V, 60 Hz, 3 phase, Induction Type
	Insulation	Class B
	Enclosure	Open Drip-proof
	Code	NEMA
3.	Heating Coils	
	Quantity, Total	6
	Type	Electric
	Capacity (KW) Each	42
	Code	Underwriters Laboratories (UL) National Electrical Manufacturers Association (NEMA), National Electric Code (NEC)
4.	Medium Efficiency Filter	
	Quantity, Total	1
	Type	Extended Medium
	Material	Synthetic or Fiberglass
b)	AIR CONDITIONING UNIT (Office and Laundry)	
	Quantity	Two Units
	Each unit contains the following:	
1.	Supply Fans	
	Quantity	1
	Type	Centrifugal, Belt Driven Office and Laundry
	Air Flow Each Fan, acfm	20,000 and 11,000
	Code	Air Movement and Control Association (AMCA), Anti-Friction Bearing Manufacturers Association (AFBMA)
2.	Motors	
	Quantity, Per Fan	1
	Type	25 Hp and 15 Hp, 460 Volts, 60 Hz, 3 phase, Induction Type
	Insulation	Class F and B
	Enclosure	Open Drip-proof
	Code	NEMA
3.	Cooling Coils	
	Quantity, Each Unit	1
	Type	Chilled Water Finned Tube
	Material	Copper Fin on Copper Tube
4.	Heating Coil	
	Quantity, Each Unit	1
	Type	Electric
	Capacity (KW)	216 and 154

Table 9.4.3-5 (Continued)

	Code	Underwriters Laboratories (UL) National Electrical Manufacturers Association (NEMA), National Electric Code (NEC)
5.	Medium Efficiency Filter	
	Quantity, Each Unit	1 Bank
	Type	Extended Media
	Material	Synthetic or Fiberglass
c)	ELECTRIC REHEAT COILS (In the Supply Ducts)	
	Quantity, Total	8: EHC 46,47,48,49,50,51,52 & 103
	Type	Electric
	Capacity	15, 15, 15, 20, 29, 17, 17 and 48
	Code	Underwriters Laboratories (UL) National Electrical Manufacturers Association (NEMA), National Electric Code (NEC)
d)	RECIRCULATING FAN	
1.	Fan	
	Quantity	1
	Air Flow, acfm	16,000
	Code	Air Movement and Control Association (AMCA), Anti-Friction Bearing Manufacturers Association (AFBMA)
2.	Motors	
	Quantity	1
	Type	20 Hp, 460 Volts, 60 Hz, 3 Phase, Induction Type
	Insulation	Class B
	Enclosure	Open Drip-proof
	Code	NEMA
e)	EXHAUST SYSTEM	
1.	Fans	
	Quantity, Total	2: E-51,E-77
	Air Flow, acfm	9600 and 2700
	Code	Air Movement and Control Association (AMCA). Anti-Friction Bearing Manufacturers Association (AFBMA)
2.	Motors	
	Quantity, Total	2
	Type	10 Hp & 3 Hp, 460 Volts, 60 Hz, 3 Phase, Induction Type
	Insulation	Class B
	Enclosure	Open Drip-proof
	Code	NEMA
3.	Booster Fans	
	Quantity, Total	6
	Air Flow, acfm	4,000
	Code	Air Movement and Control Association (AMCA). Anti-Friction Bearing Manufacturers Association (AFBMA)
4.	Motors	
	Quantity	6
	Type	7 1/2 Hp, 460 V, 60 Hz, 3 Phase, Induction Type
	Insulation	Class B
	Enclosure	Open Drip-proof
	Code	NEMA, Class B

TABLE 9.4.3-6

DESIGN DATA FOR WPB LABORATORY AREAS HVAC SYSTEM

a) SUPPLY AIR HANDLING UNITS	
1. Supply Fans	
Quantity, Total	3
Air Flow, (approx.)	One fan at 5000 acfm (AH-66) One fan at 4000 acfm (AH-67) One fan at 4200 acfm (AH-68)
Code	Air Movement and Control Association (AMCA), Anti-Friction Bearing Manufacturers Association (AFBMA)
2. Heating Coil	
Quantity	1 per air handling unit
Type	Electric
Capacity (KW)	One coil at 85 One coil at 68 One coil at 72
Code	Underwriters Laboratories (UL) National Electrical Manufacturers Association (NEMA), National Electric Code (NEC)
3. Medium Efficiency Filter	
Quantity per unit	1 Bank
Type	Extended media
Material	Synthetic or Fiberglass
b) AIR CONDITIONING UNIT	
1. Supply Fan	
Quantity	1
Air Flow (acfm)	14,000
Code	Air Movement and Control Association (AMCA), Anti-Friction Bearing Manufacturers Association (AFBMA)
2. Cooling Coils	
Quantity	1
Type	Chilled Water Finned Tube
Material	Copper Fin on Copper Tube
3. Heating Coil	
Quantity	1
Type	Electric
Capacity (KW)	196
Code	Underwriters Laboratories (UL) National Electric Manufacturers Association (NEMA), National Electric Code (NEC)
4. Medium Efficiency Filters	
Quantity	One Bank
Type	Extended Media
Material	Synthetic or Fiberglass
c) FUME HOOD EXHAUST SYSTEM	
1. Fans	
Quantity, Total	14 One Fan at 387: E-87 Three at 1000 each: E-64,65,66

Table 9.4.3-6 (Continued)

Air Flow, acfm	Four fans at 1250 each: E-69,70,73,74 Four fans at 1500 each: E-62,63,71,72 One fan at 1565: E-75 One fan at 1875: E-67
Code	Air Movement and Control Association (AMCA), Anti-Friction Bearing Manufacturers Association (AFBMA)
2. HEPA Filters	
Quantity	2 (one per fan); E-74 and E-75
Cell (Unit) Size	24"H x 24"W x 11-1/2" deep
Max resistance, clean in. wg.	1.0
Max resistance, loaded in. wg.	2.0
Efficiency	99.97
Material	Meets the requirements of ANSI/ASME N509-1980
d) EXHAUST SYSTEM	
1. Fans	E-52, E-82
Quantity	2
Air Flow, acfm	9050 4950
Code	Air Movement and Control Association (AMCA), Anti-Friction Bearing Manufacturers Association (AFBMA)

TABLE 9.4.3-7

DESIGN DATA FOR WPB INSTRUMENT AND CONTROL SHOP

a)	SUPPLY SYSTEM	
	1. Supply Fans	
	Quantity	1
	Air Flow, acfm	3500
	Code	Air Movement and Control Association (AMCA), Anti-Friction Bearing Manufacturers Association (AFBMA)
	2. Supply Fan Motors	
	Quantity	1
	Type	5 Hp, 460 V, 3 Phase, Induction Type
	Insulation	Class B, Powerhouse
	Enclosure	Open Drip-proof
	Code	NEMA, Class B
	3. Cooling Coil	
	Quantity	1
	Type	Chilled Water Finned Tube
	Material	Copper Fin on Copper Tube
	4. Heating Coil	
	Quantity	1
	Type	Electric
	Capacity	49
	Code	Underwriters Laboratories (UL) National Electrical Manufacturers Association (NEMA), National Electric Code (NEC)
	5. Medium Efficiency Filters	
	Quantity	One Bank
	Type	Extended media
	Material	Synthetic or Fiberglass
	6. Reheat Coil	
	Quantity	1
	Type	Electric, 460 V, 3 Phase, 60 Hz
	Capacity (KW)	26
	Code	Underwriters Laboratories (UL) National Electrical Manufacturers Association (NEMA), National Electric Code (NEC)

TABLE 9.4.4-1

DESIGN DATA FOR TURBINE BUILDING CONDENSATE POLISHING DEMINERALIZER AREA VENTILATION SYSTEM

a)	SUPPLY SYSTEM	
	Quantity One Unit	
	The unit contains the following:	
	1. Supply Fans	
	Quantity	2 (1 Stand-By)
	Type	Centrifugal, Belt Driven
	Air Flow, Each Fan, acfm	22,500
	Code	Air movement and Control Association (AMCA), Anti-Friction Bearing Manufacturers Association (AFBMA)
	2. Supply Fan Motors	
	Quantity, Per Fan	1
	Type	40 HP, 460 V, 60 Hz, 3 phase, Induction Type
	Insulation	Class H
	Enclosure	TEFC/XT
	Code	NEMA
	3. Heating Coil (EHC-108)	
	Quantity, Total	1
	Type	Electric
	Capacity (KW)	375
	Code	Underwriters Laboratories (UL), National Electric Manufacturers Association (NEMA), National Electric Code (NEC)
	4. Medium Efficiency Filter	
	Quantity, Total	1 Bank
	Type	Extended Media
	Material	Synthetic or Fiberglass
b)	FILTERED EXHAUST SYSTEM	
	Quantity	One Unit
	The unit contains the following:	
	1. Exhaust Fans (E-60)	
	Quantity	2 (1 Stand-By)
	Type	Centrifugal with variable inlet vanes, single width, single inlet, direct drive.
	Air Flow, Per Fan, acfm	24,500
	Code	Air Movement and Control Association (AMCA), Anti-Friction Bearing Manufacturers Association (AFBMA)
	2. Exhaust Fan Motors	
	Quantity, Per Fan	1
	Type	75 Hp, 460 V, 60 Hz, 3 phase, Induction Type
	Insulation	Class H
	Enclosure	Drip-Proof
	Code	NEMA
	3. HEPA Filters	
	Quantity, Per system	1 Bank
	Cell, (Unit) Size	24" Hx24" Wx11-1/2" deep
	Max resistance clean, in. wg.	1.0

Table 9.4.4-1 (Continued)

Max resistance loaded, in. wg.	2.0
Efficiency	99.97 percent when tested with 0.3 micron Dioctylptalate smoke
Material	Meets the requirements of ANSI/ASME N509-1980
4. <u>Charcoal Adsorbers</u>	
Type	Impregnated
Quantity, Per System	1 Bank at 4" depth of bed
Efficiency:	
New Activated Carbon (per 2 inch bed depth except as noted)	At least 99.9% of molecular iodine and at least 97% of methyl iodide when tested at 30°C and 95% relative humidity. At least 99% of methyl iodide when tested at 80°C and 95% relative humidity. At least 98% of methyl iodide when tested at 130°C and 95 relative humidity. At least 99.5% of molecular iodine per 1 inch bed depth when tested at 180°C.
Lab Test for Representative Samples of Used Carbon (18 month test requirement)	At least 90% of methyl iodide when tested at 30°C and 70% relative humidity.
Material	Activated coconut shell charcoal. Material in contact with charcoal shall be 304 stainless steel ASTM A240
Face Velocity (fpm)	40
5. <u>Prefilters</u>	
Quantity, Per System	1 Bank
Type	Medium efficiency extended media
Material	Synthetic or Fiberglass

TABLE 9.4.4-2

DESIGN DATA FOR TURBINE BUILDING ELECTRICAL AND BATTERY ROOMS VENTILATION SYSTEM

a)	SUPPLY SYSTEM	
	Quantity	One Unit
	The unit contains the following:	
	1. Supply Fans	
	Quantity	2 (1 Stand-By)
	Type	Centrifugal, Belt Driven
	Air Flow, Each Fan, acfm	45,720
	Code	Air Movement and Control Association (AMCA), Anti-Friction Bearing Manufacturers Association (AFBMA)
	2. Supply Fan Motors	
	Quantity, Per Fan	1
	Type	60 HP, 460 V, 60 Hz, 3 Phase, Induction Type
	Insulation	Class F
	Enclosure	Open Drip-Proof
	Code	NEMA
	3. Heating Coil (EHC-32)	
	Quantity, Total	1
	Type	Electric
	Capacity (KW)	250
	Code	Underwriters Laboratories (UL), National Electrical Manufacturers Association (NEMA), National Electric Code (NEC)
	4. Medium Efficiency Filter	
	Quantity, Per Unit	1 Bank
	Type	Extended Media
	Material	Synthetic or Fiberglass
	5. Heat Coil	
	Quantity	1
	Type	Electric
	Capacity (KW)	26
	Code	Underwriters Laboratories (UL), National Electric Manufacturers Association (NEMA), National Electric Code (NEC)
b)	EXHAUST SYSTEM FOR BATTERY ROOM	
	1. Exhaust Fans	
	Quantity	2 (1 Stand-By)
	Type	Centrifugal, Belt Driven
	Air Flow, Per Fan, acfm	3,240
	Code	Air Movement and Control Association (AMCA), Anti-Friction Bearing Manufacturers Association (AFBMA)
	2. Exhaust Fan Motors	
	Quantity, Per Fan	1
	Capacity	2 HP, 460 V, 60 Hz, 3 phase, Induction Type
	Insulation	Class B
	Enclosure	Drip-Proof
	Code	NEMA

TABLE 9.4.4-3

DESIGN DATA FOR TURBINE BUILDING GENERAL SERVICE SWITCHGEAR ROOM VENTILATION SYSTEM

a) SUPPLY SYSTEM
Quantity One Unit
The unit contains the following:

1. Supply Fans	
Quantity	2 (1 Stand-by)
Type	Centrifugal, Belt Driven
Air Flow, Each Fan, acfm	9,000
Code	Air Movement and Control Association (AMCA), Anti-Friction Bearing Manufacturers Association (AFBMA)
2. Supply Fan Motors	
Quantity, Per Fan	1
Type	10 HP, 460 V, 60 Hz, 3 Phase Induction Type
Insulation	Class B
Enclosure	Drip-Proof
Code	NEMA
3. Heating Coil	
Quantity, Total	1
Type	Electric
Capacity (KW)	70
Code	Underwriters Laboratories (UL), National Electric manufacturers Association (NEMA), National Electric Code (NEC)
4. Medium Efficiency Filter	
Quantity, Total	1 Bank
Type	Extended Media
Material	Synthetic or Fiberglass

TABLE 9.4.4-5

DESIGN DATA FOR TURBINE BUILDING ELEVATOR MACHINE ROOM VENTILATION SYSTEM AND SAMPLING ROOM HVAC SYSTEM

ELEVATOR MACHINE ROOM

1. Exhaust Fan (E-92)	
Quantity	1
Type	Centrifugal, Wall Mounted
Air Flow, Per Fan, acfm	3300
Code	Air Movement and Control Association (AMCA)
2. Exhaust Fan Motor	
Quantity, Per Fan	1
Capacity	2 HP, 460 V, 60 Hz, 3 phase, Induction Type
Insulation	Class B
Enclosure	TEFC
Code	NEMA
3. Unit Heaters (EUH-58)	
Quantity	1
Type	Electric, 460 V, 3 Phase, 60 Hz
Capacity (KW)	20
Code	Underwriters Laboratory (UL) National Electric Code (NEC) National Electric Manufacturers Association (NEMA)

SAMPLING ROOM

1. Exhaust Fan (E-44)	
Quantity	1
Type	Centrifugal, Wall Exhaust Fan
Air Flow acfm	1480
HP	1/4
Code	AMCA
V/O/HZ	115/1/60
2. Finned Tube Tadiaiton (EFT-1)	
Quantity	36 lin. feet
Type	Electric
Capacity (kw)	16.3 Induction Type
Code	UL
V/O/HZ	208/1/60

TABLE 9.4.4-6

DESIGN DATA FOR SECONDARY SAMPLING EQUIPMENT ENCLOSURE

1. Condensing units	(SS-1, SS-2)
Quantity	2
Type	Split system
Capacity	4 Tons
V/O/Hz	208/3/60
2. Air handlers	(AH #1, AH #2)
Quantity	2
Type	Split system
Capacity	4 Tons
Air flow	1600 cfm
V/O/Hz	208/3/60

TABLE 9.4.5-1

DESIGN DATA FOR ESF EQUIPMENT COOLING SYSTEM

1. Air Handling Units Fan Section

Quantity	18
Type	Centrifugal, Belt Driven
Air Flow	

UNIT IDENT.	AREA SERVED	AIR FLOW PER UNIT acfm
AH-5	RHR and Containment Spray Pump Area El. 190' RAB	15,000
AH-6	Component Cooling Pumps & Heat Exch. and Aux. Feedwater Pump Area El. 236' RAB	15,000
AH-7	Component Cooling Pumps & Heat Exch. and Aux. Feedwater Pump Area El. 236' RAB	15,000
AH-8	Service Water Booster Pump SB Areas El. 236' RAB	7,300
AH-9	Charging Pump SA & SB Areas El. 236' RAB	7,500
AH-10	Charging Pump IC-SAB Area El. 236' RAB	7,500
AH-11	Mechanical Penetration Area El. 236' RAB	17,000
AH-17	Spent Fuel Pool Cooling Pumps & Heat Exch. Space El. 236' FHB	18,000
AH-19	HVAC Chiller Pump Aux. Feedwater Piping & Valve Area El. 261' RAB	10,000
AH-20	HVAC Chiller Pump Aux. Feedwater Piping & Valve Area El. 261' RAB	10,000
AH-23	Mechanical & Electrical Penet. Area El. 236' RAB (Col. Line 24-41-L-JY)	2,300
AH-24	Electrical Penetration Area El. 261’ RAB (Col. Line 15-26-E-H)	4,100
AH-25	Electrical Penetration Area SB and MCC-1B-24 (Misc. Loads) El. 261’ RAB	3,200
AH-26	H&V Equip. Rm SA & SB El. 261’ RAB (Col. Line 31-43-I-L)	3,500
AH-28	Cont. Spray Tank, Boron Injection Tank & Pump Area El. 216’ RAB (Col. Line 15)	9,000
AH-29	Cont. Fan Cool. Starter (1B-22-SB for AH-1) Area EL 236.0’ WTA (RAB)	2,000
AH-92	RAB MCC 1A-35SA & MCC 1B-35SB Area El. 261’ RAB	4,100
AH-93	Rod Control Cabinet & RM Area El. 305’ RAB	4,100

CODE	Air Movement and Control Association (AMCA), Anti-Friction Bearing Manufacturers Association (AFBMA).

2. Fan Motors

Quantity, Per Fan	1
Type	460 V, 60 Hz, 3 Phase,Horizontal Induction Type
Horsepower:	

UNIT IDENT.	AREA SERVED	MOTOR HORSE-POWER
AH-5	RHR and Cont. Spray Pump Area El. 190' RAB	7-1/2
AH-6	Component Cooling Pumps and Heat Exch. and Aux. Feedwater Pump Area El. 236' RAB	10
AH-7	Component Cooling Pumps and Heat Exch. and Aux. Feedwater Pump Area El. 236' RAB	10
AH-8	Service Water Booster Pump SB Area El. 236' RAB	5
AH-9	Charging Pump SA & SB Areas El. 236' RAB	7-1/2
AH-10	Charging Pump 1C-SAB Area El. 236' RAB	10
AH-11	Mechanical Penetration Area El. 236' RAB	10
AH-17	Spent Fuel Pools Cooling Pumps and Heat Exch. Space El. 236' FHB	20
AH-19	HVAC Chiller Pump Aux. Feedwater Piping and Valve Area El. 261' RAB	7-1/2
AH-20	HVAC Chiller Pump Aux. Feedwater Piping and Valve Area El. 261' RAB	7-1/2
AH-23	Mechanical and Electrical Penet. & Cont. Fan Cool. Starter (MCC 1A22-SA for AH-2) Area El. 236' RAB	2
AH-24	Electrical Penetration Area SA & MCC-1A24 (Misc. Loads) Area El. 261' RAB	3
AH-25	Electrical Penetration Area SB & MCC-1B24 (Misc. Loads) Area El. 261' RAB	3
AH-26	RAB Emerg. Equip. RM SA and SB Area El. 261' RAB	3
AH-28	Cont. Spray Tank, Boron Injection Tank and Pump Instrument Racks and Rad. Monitors Area El. 216' RAB	5
AH-29	Cont. Fan Cool. Starter (MCC 1B22-SB) for AH-1) Area El. 236' WTA	2
AH-92	RAB MCC 1A-35SA & MCC 1B-35SB Area El. 261' RAB	5
AH-93	Rod Control Cabinets Rm Area El. 305' RAB	5

Table 9.4.5-1 (Continued)

Insulation	H
Enclosure	TEFC
Code	NEMA, IEEE, Class IE
3. <u>Cooling Coils</u>	
Quantity, Per Fan Cooler	1
Type	Chilled water, finned tube copper fins on copper tube
Code	ASME III, Code Class 3
4. <u>Medium Efficiency Filters</u>	
Quantity, Per Fan Cooler	1
Type:	

UNIT IDENT.	AREA SERVED	TYPE
AH-5	RHR and Cont. Spray Pump Area El. 190' RAB	Permanent, Flat Media
AH-6	Component Cooling Pumps and Heat Exch. and Aux. Feedwater Pump Area El. 236' RAB	Throwaway and Permanent, Extended Media
AH-7	Component Cooling Pumps and Heat Exch. and Aux. Feedwater Pump Area El. 236' RAB	Throwaway and Permanent Extended Media
AH-8	Service Water Booster Pump SB Area El. 236' RAB	Permanent, Flat Media
AH-9	Charging Pump SA & SB Areas El. 236' RAB	Throwaway and Permanent Extended Media
AH-10	Charging Pump 1C-SAB Area El. 236' RAB	Throwaway and Permanent Extended Media
AH-11	Mechanical Penetration Area El. 236' RAB	Throwaway and Permanent Extended Media
AH-17	Spent Fuel Pools Cooling Pumps and Heat Exch. Space El. 236' FHB	Throwaway and Permanent Extended Media
AH-19	HVAC Chiller Pump Aux. Feedwater Piping and Valve Area El. 261' RAB	Throwaway and Permanent Extended Media
AH-20	HVAC Chiller Pump Aux. Feedwater Piping and Valve Area El. 261' RAB	Throwaway and Permanent, Extended Media
AH-23	Mechanical and Electrical Penet. & Cont. Fan Cool Starter (1A22-SA for AH-22) Area El. 236' RAB	Throwaway and Permanent, Extended Media
AH-24	Electrical Penetration Area SA MCC 1A-24 (Misc. Loads Manually Diesel Loaded) Area El. 261' RAB	Throwaway and Permanent, Extended Media
AH-25	Electrical Penetration Area SB & MCC 1B-24 (Misc. Loads Manually Diesel Loaded) Area El. 261' RAB	Throwaway and Permanent, Extended Media
AH-26	RAB Emerg. Equip. RM SA and SB Area El. 261' RAB	Throwaway and Permanent, Extended Media
AH-28	Cont. Spray Tank, Boron Injection Tank and Pump Instrument Racks and Rad. Monitors Area El. 216' RAB	Permanent, Extended Media
AH-29	Cont. Fan Cool. Starter (1B-22-SB for AH-1) Area El. 236' WTA	Throwaway and Permanent, Extended Media
AH-92	RAB MCC 1A-35SA & MCC 1B-35SB Area El 261' RAB	Throwaway
AH-93	Rod Control Cabinet Rm Area El. 305' RAB	Throwaway

Material	Glass fiber
<u>HV Penetration Area Fan S-68 (1X-SA)</u>	
1. Quantity	1
Type	Vane Axial
Air Flow ACFM	1300
Code	AMCA
2. <u>Motor</u>	
Quantity	1
Horsepower	3
Electrical Characteristics	460 V, 3 phase, 60 Hz

Table 9.4.5-1 (Continued)

Enclosure	TEAO
Insulation	Class H
Code	NEMA, IEEE Class 1E

TABLE 9.4.5-2

DESIGN DATA FOR RAB STEAM TUNNEL VENTILATION SYSTEM

Steam Tunnel Ventilation System

1. Supply

Quantity	2
Type	In-line fan
Air Flow per fan, cfm	40,000
Code	Air Movement and Control Association (AMCA), Anti-Friction Bearing Manufacturers Association (AFBMA)

2. Motors

Quantity, per fan	1
Type	30 HP, 460 V, 60 Hz, 3 phase
Insulation	Class H, Type RH
Enclosure	TEAO
Code	NEMA, IEEE Class IE

TABLE 9.4.5-3

DESIGN DATA FOR RAB SWITCHGEAR ROOM VENTILATION SYSTEM AND CABLE SPREADING ROOM SMOKE PURGE SYSTEM

RAB Switchgear Room Ventilation System

1. Air Handling Units Fan Section (AH-12, AH-13)	
Quantity, Per System	2, 100% each
Type	Centrifugal, Belt Driven
Air Flow, cfm	25150 (AH-12, Switchgear Room "A") 32000 (AH-13, Switchgear Room "B")
Code	Air Movement and Control Association (AMCA), Anti-Friction Bearing Manufacturers Association (AFBMA)
2. Motors	
Quantity, Per Fan	1
Type	460 V, 60 z, 3 Phase
Horsepower:	
Switchgear Room "A" (AH-12)	75
Switchgear Room "B" (AH-13)	75
Insulation	Class H
Enclosure	TEFC
Code	NEMA, IEEE Class IE
3. Cooling Coils	
Quantity, Per Unit	2
Type	Chilled water, finned tubes
Material	Copper fins on copper tube
Code	ASME III, Code Class 3
4. Medium Efficiency Filters	
Quantity, Per Unit	1 Bank
Type	Extended media
Material	Glass fiber
5. Heating Coils	
Quantity, Per Unit	1
Type	Electric
Capacity (kw):	
Switchgear Room "A" (AH-12)	112
Switchgear Room "B" (AH-13)	103
Code	Underwriters Laboratories (UL), National Electrical Manufacturers Association (NEMA), National Electric Code (NEC)
6. Exhaust Fans	
Quantity, Per System	2, 100% each
Type	Centrifugal single width, single inlet, Belt Driven
Air Flow, Per Fan, cfm	3000
Code	Air Movement and Control Association (AMCA), Anti-Friction Bearing Manufacturers Association (AFBMA)
7. Exhaust Fan Motors	
Quantity, Per Fan	1
Type	3 Hp, 460 V, 60 Hz, 3 Phase

Table 9.4.5-3 (Continued)

Insulation	Class H
Enclosure	TEFC
Code	NEMA, IEE Class IE
8. Cable Spreading Room Smoke Purge System	
Purge Fans	
Type	Axial Centrifugal High Temperature
Quantity	2, 100%
Capacity (cfm) Per Fan	6,300
Motor hp	25, 460 V, 3 phase & 60 Hz
9. Split System Fan Coil Unit with Compressor FCC-1 (1X-NNS)	
Fan Air Flow, acfm	1600
Fan Motor Horsepower	1
Electrical Characteristics	460 volts, 3 phase, 60 Hz
Cooling	
Capacity, Total BTUH	54,300
Compressor Voltage	460 volts, 3 phase, 60 Hz
Compressor KW Input	6
10. Air Cooled Condenser ACC1 (1X-NNS)	
Condenser Fan Air Flow, acfm	4,500
Motor Horsepower	3/4
Electrical Characteristics	460 volts, 1 phase, 60 Hz
Maximum KW, actual	0.74

TABLE 9.4.5-4

DESIGN DATA FOR RAB EQUIPMENT PROTECTION ROOM VENTILATION SYSTEM AND SMOKE PURGE SYSTEM

RAB Equipment Protection Room Ventilation System

1. Air Handling Units Fan Section	
Quantity, Per System	2, 100% each
Type	Centrifugal, Belt Driven
Air Flow, Per Fan, cfm	15,000
Code	Air Movement and Control Association (AMCA), Anti-Friction Bearing Manufacturers Association (AFBMA)
2. Motors	
Quantity, Per Fan	1
Type	30 Hp, 460 V, 60 Hz, 3 Phase
Insulation	Class H
Enclosure	TEFC
Code	NEMA, IEEE Class IE
3. Cooling Coils	
Quantity, Per Unit	1
Type	Chilled water, finned tube
Material	Copperfins on copper tube
Code	ASME III, Code Class 3
4. Medium Efficiency Filters	
Quantity, Per Unit	1 Bank
Type	Extended media
Material	Glass fiber
5. Heating Coils	
Quantity, Per System	1
Type	Electric
Capacity (kw)	73
Code	Underwriters Laboratories (UL), National Electrical Manufacturers Association (NEMA), National Electric Code (NEC)
6. Exhaust Fans	
Quantity, Per System	2, 100% each
Type	Centrifugal, single width, single inlet, Belt Driven
Air Flow, Per Fan, cfm	850
Code	Air Movement and Control Association (AMCA), Anti-Friction Bearing Manufacturers Association (AFBMA)
7. Exhaust Fan Motors	
Quantity, Per Fan	1
Capacity	1 Hp, 460 V, 60 Hz, 3 Phase
Insulation	Class H
Enclosure	TEFC
Code	NEMA IEEE, Class IE

Equipment Protection Room Smoke Purge System

1. Purge Fans

2. Table 9.4.5-4 (Continued)

Type	Axial Centrifugal High Temperature
Quantity	2, 100% each
Capacity (cfm) per fan	14,050
Motor hp	25, 460 V, 3 phase and 60 Hz

TABLE 9.4.5-5

DESIGN DATA FOR FUEL OIL TRANSFER PUMP ROOM VENTILATION SYSTEM

1. Exhaust Fans	
Quantity	2 (one standby)
Type	In-line Vaneaxial Fan (Direct drive)
Air Flow per fan, acfm	1300
External total pressure, in. wg.	1.125
Code	Air Movement and Control Association (AMCA), Anti-Friction Bearing Manufacturer's Association (AFBMA)
2. Exhaust Fan Motors	
Quantity, per fan	1
Type	3 Hp, 460 V, 60 Hz and Phase
Insulation	Class H, Type RH
Enclosure	TEAO
Code	NEMA, IEEE Class IE
3. Electric Unit Heaters	
Quantity	4
Type	Electric
Capacity (kw)	50
Code	Underwriter Laboratories (UL), National Electrical Manufacturers Association (NEMA), National Electric Code (NEC)

TABLE 9.4.5-6

DESIGN DATA FOR DIESEL GENERATOR BUILDING VENTILATION SYSTEM COMPONENTS

A. Air Handling Unit (AH-85)	
1. Fan	
Quantity, per system	2 (one operating and one standby)
Type	Centrifugal, Belt driven
Air Flow cfm	12,000
Code	Air Movement and Control Association (AMCA), Anti-Friction Bearing Manufacturers Association (AFBMA)
2. Motors	
Quantity, per fan	1
Type	460 V, 60 Hz, 3 Phase
Horsepower	15
Insulation	Class B
Enclosure	TEFC
Code	NEMA, IEEE Class IE
3. Cooling Coil	Not Used
Quantity, per unit	1
Type	Service Water, finned tubes
Material	Copper fins on copper tube
Code	ASME III, Code Class 3
4. Electric Heating Coils	
Quantity, per unit	1
Type	Electric
Capacity (KW)	50
Code	Underwriters Laboratories (UL) National Electric Manufacturers Association (NEMA) National Electric Code (NEC)
5. Medium Efficiency Filters	
Quantity, per unit	1 Bank
Type	Extended Media
Material	Glass Fiber
B. Exhaust Systems (E-86)	
1. Exhaust Fans	
Quantity	2
Type	In-line vaneaxial Fans (Direct Drive)
Air flow per fan, acfm	57,000
External total pressure, in. wg.	3.2
Code	Air Movement and Control Association (AMCA), Anti-Friction Bearing Manufacturers Association (AFBMA)
2. Exhaust Fan Motors	
Quantity, per fan	1
Type	50 Hp, 460 V, 60 Hz and 3 Phase
Insulation	Type RH Class H
Enclosure	TEAO
Code	NEMA, IEEE Class IE

Table 9.4.5-6 (Continued)

C. Exhaust System (E-61)	
1. Fans	
Quantity, per system	2
Type	Centrifugal, single width single inlet, Belt Driven
Air Flow, acfm	5500
Code	Air Movement and Control Association (AMCA), Anti-Friction Bearing Manufacturers Association (AFBMA)
2. Fan Motors	
Quantity, per fan	1
Type	5 Hp, 460 V, 60 Hz, 3 Phase
Insulation	Class H Powerhouse
Enclosure	TEFC
Code	NEMA, IEEE Class IE
D. Electric Unit Heaters	
Quantity	5
Type	Electric
Capacity (kw)	50 (EUH-51, 52) (estimate) 20 (EUH-61, 62 & 63) (estimate)
Code	Underwriter Laboratories (UL) National Electrical Manufacturers Association (NEMA) National Electric Code (NEC)
E. Filters AH-99 and AH-100	
Quantity	2 Banks
Type	Flat Throwaway
Material	Glass Fiber

TABLE 9.4.5-7

DESIGN DATA FOR EMERGENCY SERVICE WATER INTAKE STRUCTURE VENTILATION SYSTEM COMPONENTS

A. Air Handling Unit (AH-86)	
1. Fan	
Quantity, per system	1
Type	Centrifugal - Belt Drive
Air Flow CFM	9500
Code	Air Movement and Control Association (AMCA), Anti-Friction Bearing Manufacturers Association (AFBMA)
2. Motors	
Quantity	1
Type	460 V, 60 Hz, 3 Phase
Horsepower	10
Insulation	H - Type RH
Enclosure	TEFC
Code	NEMA, IEEE Class IE
3. Cooling Coil (Isolated)	
Quantity, per unit	1
Type	Service water, finned tubes
Material	Copper fins on copper tube
4. Electric Heating Coils	
Quantity, per unit	1
Type	Electric
Capacity (kw)	35
Code	Underwriters Laboratories (UL) National Electrical Manufacturers Association (NEMA) National Electric Code (NEC)
5. Medium Efficiency Filters	
Quantity, per unit	1 Bank
Type	Extended Media
Material	Glass fiber
B. Pump Room Exhaust System (E-88)	
1. Exhaust Fans	
Quantity	1
Type	In-line vaneaxial Fans (Direct Drive)
Air flow per fan, acfm	12,000
External total pressure,in. wg.	2.0
Code	Air Movement and Control Association (AMCA), Anti-Friction Bearing Manufacturers Association (AFBMA)
2. Exhaust Fan Motors	
Quantity, per fan	1
Type	15 Hp, 460 V, 60 Hz and 3 Phase
Insulation	Type RH Class H
Enclosure	TEAO
Code	NEMA, IEEE Class IE
C. Electric Unit Heaters	
Quantity	2
Type	Electric

Table 9.4.5-7 (Continued)

Capacity KW	12.5 (EUH-59); 15 (EUH-60)
Code	Underwriter Laboratories (UL) National Electrical Manufacturers Association (NEMA) National Electric Code

TABLE 9.4.5-8

REACTOR AUXILIARY BUILDING ESF EQUIPMENT COOLING FAN-COOLERS
SINGLE FAILURE ANALYSIS

COMPONENT IDENTIFICATION	FAILURE MODE	EFFECT ON SYSTEM	METHOD OF DETECTION	MONITOR	REMARKS
Fan	Fails to Operate	Loss of Cooling Air for the served area.	Low Flow Alarm	C.R.I.*	Redundant capacity standby unit provided
Cooling Coil	Fails to function	Increase in Supply Air Temperature	Thermocouple on Discharge Duct	C.R.I.	Redundant capacity standby unit provided
Filter	Clogs	Air Flow Reduction	Low Flow Alarm	C.R.I.	Filter is accessible for replacement
Diesel Generator	Fails to function	Fan-Cooler fails to run.	Diesel Generator malfunction alarm	C.R.I.	Redundant capacity standby unit provided

*Control Room Indication

TABLE 9.4.5-9

REACTOR AUXILIARY BUILDING SWITCHGEAR ROOMS
VENTILATION SYSTEM SINGLE FAILURE ANALYSIS
1 SWITCHGEAR ROOM "A"

COMPONENT IDENTIFICATION	FAILURE MODE	EFFECT ON SYSTEM	METHOD OF DETECTION	MONITOR	REMARKS
Motorized Damper	Fails to Open	Loss of Outside Air	Low Flow Alarm	C.R.I.*	Operator manually hand wheel opens affected valve
Filter	Clogs	Air Flow Reduction	Low Flow Alarm	C.R.I.	Filter is accessible for replacement
Cooling Coil	Fails to function	Increase in Supply Air Temperature	Thermocouple on Discharge Duct	C.R.I.	Redundant capacity standby unit provided
Motorized Damper	Fails to Open	Loss of Supply Air	Low Flow Alarm	C.R.I.	Redundant capacity standby unit provided
Supply Fan	Fails to Operate	Loss of One of the Two Redundant Cooling Trains	Low Flow Alarm	C.R.I.	Redundant capacity standby unit provided
Gravity Damper	Fails to Open	Loss of Supply Air	Position Limit SW.	C.R.I.	Redundant capacity standby unit provided
Exhaust Fan	Fails to Operate	Hydrogen Level Rises in Battery Room	Low Flow Alarm	C.R.I.	Redundant capacity standby unit provided
Gravity Damper	Fails to Open	Loss of Exhaust Air	Position Unit SW.	C.R.I.	Redundant capacity standby unit provided
Zone Reheat Electrical Coil	Fails to automatically shut down. Fails	Increase in zone Temperature	Temp. indicating Controller	C.R.I.	Coil can be manually shut off in Control Room
Motorized Damper	Fails to Open	Loss of space ventilation (Battery Room "A")	Low Flow Alarm Vent.	C.R.I.	Damper can be open manually
Diesel Generator	Fails to function	Loss of one switchgear room a/c system	D.C. malfunction alarm, flow switch at fan discharge in chilled water system	C.R.I.	Redundant capacity standby unit provided

Table 9.4.5-9 (Continued)

2 - SWITCHGEAR ROOM "B"

COMPONENT IDENTIFICATION	FAILURE MODE	EFFECT ON SYSTEM	METHOD OF DETECTION	MONITOR	REMARKS
Motorized Damper	Fails to Open	Loss of Outside Air	Low Flow Alarm	C.R.I.	Operator manually wheel opens affected valve
Filter	Clogs	Air Flow Reduction	Low Flow Alarm	C.R.I.	Filter is accessible for replacement
Cooling Coil	Fails	Increase in Supply Air Temperature	Thermocouple on Discharge Duct	C.R.I.	Redundant capacity standby unit provided
Motorized Damper	Fails to Open	Loss of Supply Air	Low Flow Alarm	C.R.I.	Redundant capacity standby unit provided
Supply Fan	Fails to Operate	Loss of One of the Two Redundant Cooling Trains	Low Flow Alarm	C.R.I.	Redundant capacity standby unit provided
Gravity Damper	Fails to Open	Loss of Supply Air	Position Limit SW.	C.R.I.	Redundant capacity standby unit provided
Exhaust Fan	Fails to Operate	Hydrogen Level Rises in Battery Room	Low Flow Alarm	C.R.I.	Redundant capacity standby unit provided
Gravity Damper	Fails to Open	Loss of Exhaust	Position Unit SW.	C.R.I.*	Redundant capacity standby unit provided
Motorized Damper	Fails to Open	Loss of Space Ventilation	Position Limit SW.	C.R.I.	Damper can be open manually
Pressure Release Damper	Fails to Open	None			
Diesel Generator	Fails to function	Loss of one switchgear room a/c system	D.C. malfunction alarm, flow switch at fan discharge, flow switch in chilled water system	C.R.I.	Redundant capacity standby unit provided

*Control Room Indication

TABLE 9.4.5-10

REACTOR AUXILIARY BUILDING ELECTRICAL EQUIPMENT PROTECTION ROOMS VENTILATION SYSTEM SINGLE FAILURE ANALYSIS

COMPONENT IDENTIFICATION	FAILURE MODE	EFFECT ON SYSTEM	METHOD OF DETECTION	MONITOR	REMARKS
Butterfly Valve	Fails to Close	Increased Contaminated Air	Position Limit SW.	C.R.I.*	Redundant capacity standby provided
Motorized Damper	Fails to Open	Loss of Supply Air	Low Flow Alarm	C.R.I.	Redundant capacity standby provided
Filter (2)	Clogs	Air Flow Reduction	Low Flow Alarm	C.R.I.	Redundant capacity standby provided
Cooling Coil	Fails	Increase in Supply Air Temperature	Thermocouple on Discharge Duct	C.R.I.	Redundant capacity standby provided
Fan	Fails to Operate	Loss of One of the Two Redundant Cooling Trains	Low Flow Alarm	C.R.I.	Redundant capacity standby provided
Gravity Damper	Fails to Open	Loss of Supply Air	Position Limit SW.	C.R.I.	Redundant capacity standby unit provided
Zone Reheat Electrical Coil	Fails to automatically shut off	Increase in zone space temperature	Temp. indicating controller	C.R.I.	Coil can be manually shut off at local control panel in Control Room
Exhaust Fan	Fails	Loss of Space Ventilation (H&V Room No. 7)	Low Flow Alarm	C.R.I.	Redundant capacity standby unit provided
Motorized Damper	Fails to Open	Loss of Space Ventilation (H&V Room No. 7)	Position Limit S.W.	C.R.I.	Redundant capacity standby unit provided

*Control Room Indication

TABLE 9.4.7-1

CONTAINMENT BUILDING AIRBORNE RADIOACTIVITY REMOVAL SYSTEM COMPONENTS

Quantity	2 Identical Units
Each unit containing the following:	
1. Exhaust Fan	S-1 (1A) and (1B)
Quantity	1 per unit
Type	Centrifugal
Material	Carbon Steel
Air Flow, Each Fan, acfm	10,000
Code	Air Movement and Control Association (AMCA), Anti-Friction Bearing Manufacturer's Association (AFBMA)
2. Exhaust Fan Motors	
Quantity, Per Fan	1 per fan
Capacity	30 HP, 460 volt, 60 Hz, 3 ph
Insulation	Class H
Enclosure	Open TEFC/XT
Code	NEMA
3. HEPA Filters	
Quantity	1 bank per unit
Cell Size	24 in. high, 24 in. wide, 11-1/2 in. deep
Max. Resistance, Clean in. wg	1.0
Max. Resistance, Loaded in. wg	2.0
Efficiency	99.97 percent when tested with a monodisperse challenge aerosol of 0.3 ± 0.03 μm diameter droplets
Material	Meets the requirements of ANSI/ASME N509-1980
Air Flow, acfm Per Bank	10,000
4. Medium Efficiency Filters	
Quantity,	1 bank per unit
Type	Extended media
Material	Glass fiber
Air Flow, acfm Per Bank	10,000
5. Charcoal Adsorbers	
Type	Impregnated
Bed Thickness, in.	4.0 inches
Air Flow, acfm Per Bank	10,000
Air Resistance, in. wg.	1.52
Efficiency:	
New Activated Carbon (per 2 inch bed depth except as noted)	At least 99.9% of molecular iodine and at least 97% of methyl iodide when tested at 30°C and 95% relative humidity. At least 99% of methyl iodide when tested at 80°C and 95% relative humidity. At least 98% of methyl iodide when tested at 130°C and 95% relative humidity. At least 99.5% of molecular iodine per 1 inch bed depth when tested at 180°C.
Lab Test for Representative Samples of Used Carbon (18 month test requirement)	At least 90% of methyl iodide when tested at 30°C and 70% relative humidity.

TABLE 9.4.7-2

NORMAL CONTAINMENT PURGE MAKE-UP SYSTEM COMPONENTS
NON-NUCLEAR SAFETY UNITS

1. Make-Up Prefilter	
Quantity	1 bank
Type	Medium efficiency extended media
Material	Synthetic or Fiberglass
Air Flow, acfm	1500
2. Make-Up Heating Coil	
Quantity	1 bank
Type	Electric
Code	Underwriter Laboratory (UL) National Electric Manufacturing Association (NEMA), National Electric Code (NEC)
Air Flow, acfm	1500
3. Fans	
Quantity	2 (one standby)
Type	Centrifugal
Material	Carbon Steel
Air Flow, Each Fan acfm	1500
Capacity (KW)	30
Code	Air Movement and Control Association Inc. (AMCA), Anti-Friction Bearing Manufacturer's Association (AFBMA)
4. Fan Motors	
Quantity	2, one per fan
Type	3 HP, 460 volt, 60 Hz, 3 phase Induction Type
Insulation	Class B
Enclosure & Ventilation	Open Drip-Proof
Code	NEMA Class B

TABLE 9.4.7-3

CONTAINMENT PRE-ENTRY PURGE SYSTEM COMPONENTS NON-NUCLEAR SAFETY UNITS

FILTRATION UNIT	
1. Exhaust Fans	E-5 (1A) and (1B)
Quantity	2 (one standby)
Type	Centrifugal type, with variable inlet vanes, Direct Drive
Material	ASTM-A366, carbon steel
Actual Air Flow and Inlet Per Fan, acfm	37,000
Code	Air Movement and Control Association Inc. (AMCA), Anti-Friction Bearing Manufacturer's Association (AFBMA)
2. Motors	
Quantity	2, one per fan
Type	150 HP, 460 volt, 60 Hz, 3 phase horizontal induction type
Insulation	Class H
Enclosure and Ventilation	Open Drip-Proof
Code	NEMA
3. Medium Efficiency Filter	
Quantity	One bank per filter train
Air Flow, acfm	37,000 Nominal
Face Velocity, fpm	250
Material	Synthetic or Fiberglass
4. HEPA Filters	
Quantity	One bank per filter train
Air Flow, acfm (Total)	37,000
Cell (Unit) Size	24 in. high, 24 in. wide, 11 1/2 in. deep
Cell Arrangement (Units)	7 wide, by 5 high
Max Resistance Clean, in. wg	1.0
Max Resistance Loaded, in. wg	2.0
Efficiency	99.97 percent when tested with 0.3 micron DOP
Material	Meets the requirements of ANSI/ASME N509-1980
2. Charcoal Adsorbers	
Type	Impregnated
Air Flow, acfm (Total)	37,000
Bed Depth, inches	4 inch total
Max Air Resistance, in. wg	2.1
Efficiency:	
New Activated Carbon (per 2 inch bed depth except as noted)	At least 99.9% of molecular iodine and at least 97% of methyl iodide when tested at 30°C and 95% relative humidity. At least 99% of methyl iodide when tested at 80°C and 95% relative humidity. At least 98% of methyl iodide when tested at 130°C and 95% relative humidity. At least 99.5% of molecular iodine per 1 inch bed depth when tested at 180°C.
Lab Test for Representative Samples of Used Carbon (18 month test requirement)	At least 90% of methyl iodide when tested at 30°C and 70% relative humidity.
Loading Capacity	2.5 mg of iodine per gram of charcoal elemental and organic

Table 9.4.7-3 (Continued)

Material	Absorber, activated coconut shell; Charcoal enclosure, stainless steel Type 316 ASTM; welded, gasketless
6. Ducts	
Material	Galvanized Sheet Metal, ASTM A-525, Class E

TABLE 9.4.7-4

CONTAINMENT PRE-ENTRY PURGE MAKE-UP SYSTEM COMPONENT

MAKE-UP HEATING UNIT

1. Make-Up Prefilter	
Quantity	1 bank
Type	Medium efficiency extended media
Material	Synthetic or Fiberglass
Air Flow, acfm	35,000
2. Make-Up Heating Coil	
Quantity	1 bank
Type	Electric
Code	Underwriter Laboratory (UL, National Electrical Manufacturing Association (NEMA)
Air Flow, acfm	35,000
Capacity (KW)	300
3. Fans	
Quantity	2 (one standby)
Type	Vane-Axial Type
Material	Carbon Steel
Actual Air Flow, acfm	35,000 nominal
Code	Air Movement and Control Association Inc. (AMCA), Anti-Friction Bearing Manufacturer's Association (AFBMA)
4. Fans Motors	
Quantity	2, one per fan
Type	60 HP, 460 volt, 60 Hz, 3 phase Induction Type
Insulation	Class F
Enclosure & Ventilation	Open Drip-Proof
Code	NEMA Class B

TABLE 9.4.8-1

CONTROL ROD DRIVE MECHANISM VENTILATION SYSTEM DESIGN DATA

Control Rod Drive Mechanism Cooling Fans:

Type	Centrifugal
Quantity	4
Drive	Direct
Capacity (cfm)	20,000
Total Pressure (in.water)	8.2

TABLE 9.4.9-1

COMPUTER AND COMMUNICATION ROOM HVAC SYSTEM

SUPPLY SYSTEM

1. Supply Fan (AH-97)	
Quantity, Total	2, (1 standby)
Type	Centrifugal, single width single inlet, belt drive
Max Design Air Flow, per Fan, acfm	15,900
Code	Air Moving and Control Association (AMCA), Anti Friction Bearing Manufacturing Association (AFBMA)
2. Supply Fan Motors	
Quantity per Fan	1
Type	20 HP, 460V, 60 Hz, 3 phase
Insulation	Class H
Enclosure	Totally enclosed fan cooled
Code	NEMA
3. Cooling Coils	
Quantity per Air Handling Unit	2 banks in series
Type	DX, Refrigerant R-22
Material	Copper fins on copper tubes
4. Medium Efficiency Filters	
Quantity	1
Type	Extended Media
Material	Synthetic or Fiberglass
5. Heating Coil (EHC-143)	
Quantity	1, duct mounted at discharge of each fan
Type	Electric
Capacity, kW	40
Code	UL, NEMA, NEC
6. Heating Coil (EHC-140)	
Quantity	1, smoke purge make-up
Type	Electric
Capacity, kW	150
Code	UL, NEMA, NEC

FILTRATION SYSTEM

1. Air Cleaning Unit Fan (R-13)	
Quantity	2, 1 standby
Type	Centrifugal, single width single inlet, direct drive
Air Flow, acfm per Fan	4150
Code	AMCA, AFBMA
2. ACU Fan Motors	
Quantity per Fan	1
Type	15 HP, 460V, 60 Hz, 3 phase

Table 9.4.9-1 (Continued)

Insulation	Class B
Enclosure	Open Drip Proof
Code	NEMA
3. <u>HEPA Filters (Pre & After)</u>	
Quantity	2 Banks Total
Cell Size	24" high, 24" wide, 11-1/2" Deep
Maximum Resistance, Clean in. wg.	1.0
Maximum Resistance, Loaded in. wg.	2.0
Efficiency	99.97% when tested with 0.3 micron DOP
Material	Meets the requirements of ANSI/ASME N509-1980
4. Charcoal Adsorbers	
Type	Multiple gasketless bed cells in air-tight housing
Quantity	1 Bank
Media	Impregnated coconut shell
Depth of Bed	4 in.
Efficiency:	
New Activated Carbon (per 2 inch bed depth except as noted)	At least 99.9% of molecular iodine except as noted)and at least 97% of methyl iodide when tested at 30°C and 95% relative humidity. At least 99% of methyl iodide when tested at 80°C and 95% relative humidity. At least 98% of methyl iodide when tested at 130°C and 95% relative humidity. At least 99.5% of molecular iodine per 1 inch bed depth when tested at 180°C.
Lab Test for Representative Samples of Used Carbon (18 month test requirement)	At least 90% of methyl iodide when tested at 30°C and 70% relative humidity.
Face Velocity, fpm	40
Average Atmosphere Residence Time	0.25 seconds per 2 inches of adsorber bed
5. <u>Medium Efficiency Filters</u>	
Quantity	1 Bank
Type	Extended Media
Material	Glass Fiber
<u>SMOKE EXHAUST SYSTEM</u>	
1. <u>Smoke Exhaust Fan (ES-7)</u>	
Quantity	1
Type	Tubular Centrifugal
Max Design Air Flow, acfm	16,000
Code	AMCA, AFBMA
2. <u>Smoke Exhaust Fan Motor</u>	
Quantity	1
Type	20 HP, 460V, 60 Hz, 3 phase
Insulation	Class B
Enclosure	Drip Proof
Code	NEMA

Table 9.4.9-1 (Continued)

REFRIGERATION SYSTEM

1. Air Cooled Condensing Unit (ACCU-3)

Quantity	2, (1 standby)
Type	R-22 Refrigerant, Roof Mounted
No. of Compressors/tons	2/25 each
No. of Fans/HP	6/1 each
Code	American Refrigeration Institute (ARI)

TABLE 9.4.9-2

BATTERY AND HVAC EQUIPMENT ROOM HVAC SYSTEM

SUPPLY SYSTEM

1. Supply Fan (AH-98)	
Quantity, Total	2, (1 standby)
Type	Centrifugal, single width single inlet, belt drive
Air Flow, per Fan, acfm	8,300
Code	AMCA, AFBMA
2. Supply Fan Motors	
Quantity, per Fan	1
Type	15 HP, 460V, 60 Hz, 3 phase
Insulation	Class H
Enclosure	Totally enclosed fan cooled
Code	NEMA
3. Cooling Coils	
Quantity	2 banks of unequal capacities in series
Type	DX, Refrigerant R-22
Material	Copper fins on copper tubes
4. Heating Coil (EHC-141)	
Quantity	1
Type	Electric
Capacity, kW	30
Code	UL, NEMA, NEC
5. Heating Coil (EHC-142)	
Quantity	1, battery rooms heating
Type	Electric
Capacity, kW	10
Code	UL, NEMA, NEC

EXHAUST SYSTEM

1. Power Room Ventilators	
Quantity	One (1) for Equipment Room, (PV-39) Two (2) for Battery Room, (PV-40A & PV-40B)
Capacity acfm	
PV-39	7600
PV-40A & PV-40B	700
Motor, HP	
PV-39	2
PV-40A & PV-40B	1/4
Code	NEMA, AMCA

TABLE 9.4.10-1

DESIGN DATA FOR TURBINE BUILDING DECONTAMINATION FACILITY HVAC SYSTEM SYSTEM COMPONENTS

A. AIR SUPPLY SYSTEM	
1. Air Handling Unit Fan Section (AH-88)	
Quantity, Total	1
Type	Centrifugal, Belt Driven
Air Flow, per fan, acfm	7800
Code	Air Moving and Conditioning Association (AMCA). Anti-Friction Bearing Manufacturers Association (AFBMA)
2. Motors	
Quantity, Total	1
Type	7 1/2 HP, 460/3/60 Horizontal
Insulation	Class B
Enclosure	Open Drip Proof
Code	NEMA
3. Cooling Coil	
Quantity, Total Banks	1, Split horizontally
Type	DX, Refrigerant R-22
Material	Copper fins on copper tube
4. Heating Coils (EHC-122)	
Quantity, Total	1
Type	Electric
Capacity (KW) per coil	170
Code	Underwriters Laboratories (UL), National Electrical Manufacturers Association (NEMA) National Electric Code (NEC)
5. Medium Efficiency Filters	
Quantity, Total Banks	1
Type	Extended Media
Material	Synthetic or Fiberglass
B. AIR COOLED REFRIGERANT CONDENSING UNIT (ACCU-9)	
Quantity	1
Type	Air Cooled Condenser
Compressor No./Tons	2/25 Ea.
Condenser fans/HP	6/1 Ea.
Electrical Characteristics	460V, 60 Hz, 3 Phase
C. NORMAL EXHAUST SYSTEM	
1. Exhaust Fans (E-90)	
Type	Tubular Centrifugal High Temperature
Quantity	2, one standby
Capacity (acfm) per fan	4120
Code	Air Moving and Condition Association (AMCA). Anti-Friction Bearing Manufacturers Association (AFBMA)
2. Motors	
Quantity, Total	2, one standby
Type	7 1/2 HP, 460/3/60 High Temperature

Table 9.4.10-1 (Continued)

Enclosure	Open Drip Proof
Code	NEMA

D. SMOKE PURGE SYSTEM

1. Purge Fan (ES-6)

Type	Tubular Centrifugal High Temperature
Quantity	1
Capacity (acfm)3600	
Code	Air Moving and Conditioning Association (AMCA). Anti Friction-Bearing Manufacturers Association (AFBMA)

2. Motors

Quantity, Total	1
Type	7 1/2 HP, 460/3/60 High Temperature
Enclosure	Open Drip Proof
Code	NEMA

TABLE 9.5.1-1

POWER BLOCK BUILDINGS

Building	Comments
Turbine Building	
Reactor Auxiliary Building	
Waste Processing Building	
Fuel Handling Building	Excluding Areas "K" and "M"
Diesel Generating Building	
Diesel Fuel Oil Storage Building	
Intake Structures	- Essential Service Water Intake Screening Structure - Essential Service Water Intake Structure
Reactor Containment Building	

TABLE 9.5.2-1

SUMMARY OF ONSITE COMMUNICATION SYSTEM CAPABILITIES AND NOISE CONSIDERATION DURING TRANSIENTS AND/OR ACCIDENTS

		COMMUNICATION SYSTEMS AVAILABLE AND MAXIMUM BACKGROUND NOISE FOR EFFECTIVE COMMUNICATIONS			
STATION	MAXIMUM ANTICIPATED SOUND LEVELS dBA	TELEPHONE (dBA)(h)	SOUND POWERED JACK STATIONS (dBA) (h)	HIGH LEVEL PAGING (dBA) (g)	PORTABLE UHF RADIO (dBA) (h)
Main Control Room	70	80(b)	80(b)	115	80(a)
Auxiliary Control Panel Area	75	80(b)	80(b)	115	80(a)
Containment Spray Pump Areas	95	100(c)	100(e)	115	100(e)
Shutdown Cooling Heat Exchanger Areas	95	100(c)	100(e)	115	100(e)
Diesel Generator Rooms	115	125(d)	130(f)	115	120(f)
Charging Pump Areas	95	100(c)	100(e)	115	100(e)
L.P. Safety Injection Pump Areas	95	100(c)	100(e)	115	100(e)
CCW Pump Areas	95	100(c)	100(e)	115	100(e)
Auxiliary Feedwater Pump Areas	95	100(c)	100(e)	115	100(e)
H.P. Safety Injection Pump Areas	95	100(c)	100(e)	115	100(e)
Essential Switchgear Rooms	85	100(c)	100(e)	115	100(e)

Notes:

a) Subject to verification during startup.
b) Standard type communication equipment.
c) Telephone equipped with noise cancelling microphones.
d) Soundproof booth or acoustic shield and noise cancelling microphones.
e) Boom microphone with ear-muff type headset.
f) Noise shielded microphone with ear-muff type headset.
g) Provided with additional power and less spacing as appropriate.
h) After the plant is operational communication capability in light of actual background noise will be evaluated. Modifications will be made if necessary.

TABLE 9.5.2-2

AVAILABLE ONSITE TELEPHONE CIRCUITS

LOCATION	LEVEL	TELEPHONE	SOUND-POWERED PHONES
Containment Bldg.	286'	5	6
Containment Bldg.	261'	5	7
Containment Bldg.	236'	5	21
Containment Bldg.	221'	5*	5
Reactor Aux. Bldg.	305'	17	24
Reactor Aux. Bldg.	286'	17	36
Reactor Aux. Bldg.	261'	11	22
Reactor Aux. Bldg.	236'	12	30
Reactor Aux. Bldg.	216'	5	7
Reactor Aux. Bldg.	190'	4	6
Fuel Handling Building	324'	1	1
Fuel Handling Building	305'	1	2
Fuel Handling Building	286'	7	15
Fuel Handling Building	261'	13	12
Fuel Handling Building	236'	12	22
Fuel Handling Building	216'	6	22
Emergency Service Water & Cooling Tower Makeup Structure	216'	4	2
Emergency Service Water Screening Structure		0	1
Technical Support Center	324'	16	1
Operational Support Center	261'	1	1
RAB (Secondary Alarm Station)	305'	1	
(Central Alarm Station)	286’	2	
RAB (Control System Computer Room)	286'	2	1
Diesel Fuel Oil Storage (Tank Area)	242'.25	1	
Refueling Water Storage (Tank Area)	261'	1	
Refueling Water Storage (Tank Area)	286'	1	

*Includes telephone in the elevator.

TABLE 9.5.3-1

SHEARON HARRIS NUCLEAR POWER PLANT
OUTLINE OF PLANT LIGHTING SYSTEMS

Building	Elevation	Normal AC Lighting (1)	Normal/Emergency A.C. Lighting (1)	Emergency D.C. Lighting (2)
1 – Containment	221	Yes	Yes	No
	236	Yes	Yes	No
	261	Yes	Yes	No
	286	Yes	Yes	No
2 – Reactor Aux.	190	Yes	Yes	Yes
	216	Yes	Yes	Yes
	236	Yes	Yes	Yes(5)
	261	Yes	Yes	Yes
	286	Yes	Yes	Yes(3)(7)
	305	Yes	Yes	No
(Main Control Room and Computer Room)	305	Yes	Yes	Yes(4)
3 – Fuel Handling	216	Yes	Yes	Yes
	236	Yes	Yes	Yes
	261	Yes	Yes	Yes
	286	Yes	Yes	Yes
	305	Yes	Yes	Yes
	324	Yes	Yes	Yes
4 – Waste Processing	211	Yes	Yes	Yes
	236	Yes	Yes	Yes
	261	Yes	Yes	Yes(6)
	276	Yes	Yes	Yes
	291	Yes	Yes	Yes
5 – Turbine Generator Area	240	Yes	Yes	Yes
	261	Yes	Yes	Yes
	286	Yes	Yes	Yes
	314	Yes	No	Yes
6 – Yard Lighting	---	Yes	No	No

Table 9.5.3-1 (Continued)

NOTES TO TABLE 9.5.3-1

1. Lighting covers all floor area.
2. Emergency DC lighting provided only for egress through local self-contained battery lighting units (except as noted in the Reactor Auxiliary Building elev. 286 and in the Main Control Room and Computer Room).
3. Emergency DC lighting provided for egress through local self-contained battery lighting units except for Auxiliary Control Room, where Emergency DC lighting is provided through station batteries and covers all working areas.
4. Control Room and Computer Room Emergency lighting is supplied from the station batteries and covers all working areas.
5. The Hot Shop located in the Reactor Auxiliary Building, Elevation 236', is not required for safe shutdown and has not been provided with N/E lighting. In the event of loss of normal lighting in this area, local battery pack lighting will provide sufficient illumination for safe and orderly evacuation of personnel.
6. The Fire Brigade Staging Area and First Aid Room in the Waste Processing Building, elevation 261', have not been provided with N/E lighting because the areas are not required to be manned for safe shutdown nor do they provide an access or egress route to or from a fire area. One and a half hour minimum self-contained DC emergency battery pack lighting has been provided for these areas.
7. The Security Complex located in the Reactor Auxiliary Building, elevation 286', is not required for safe shutdown and has not been provided with N/E lighting. In the event of loss of normal lighting in this area, local battery pack lighting will provide sufficient illumination for safe and orderly evacuation of personnel.

TABLE 9.5.4-1

DIESEL GENERATOR FUEL OIL STORAGE SYSTEM COMPONENT DESIGN DATA

1. Diesel Fuel Oil Storage Tanks	
Quantity	2
Capacity	175,000 gallons*
Type	Horizontal
Design Pressure, psig	Atmospheric
Maximum Design Temperature,F°	105 (Note 1)
Materials	Reinforced Concrete with Carbon Steel Liner
Code (Liner)	ASME B&PV Code, Section VIII (Note 2)
Seismic Category	I
2. Diesel Fuel Oil Transfer Pumps	
Quantity	2
Capacity	40 gpm
Type	Horizontal, centrifugal stainless steel
Code	ASME B&PV Code, Section III, Class 3
Seismic Category	I
3. Diesel Fuel Oil Day Tanks	
Quantity	2
Capacity	3,000 gallons
Type	Vertical
Design Pressure, psig	Atmospheric
Design Temperature, °F	125
Materials	Carbon Steel
Code	ASME B&PV Code, Section III, Class 3
Seismic Category	I
4. Fuel Oil Strainers	
Quantity	2
Type	Basket Strainer with Mesh Liner
Code	ASME B&PV Code, Section III, Class 3, Subsections ND-3600 & NA
Seismic Category	I
5. Valves	
Design Pressure, psig	100
Design Temperature, `F	125
Material	Carbon Steel
Codes	ASME B&PV Code, Section III, Class 3, NA & ND 3500
Seismic Category	I
6. Piping	
Design Pressure, psig	100
Design Temperature, `F	125
Material	Carbon Steel
Codes	ASME B&PV Code, Section III, Class 3, NA & ND 3600
Seismic Category	I

Notes:

1) The steel liner was designed considering the maximum design temperature and a differential temperature between the tank/liner and the tank's contents.

2) The liners were fabricated and erected in accordance with the ASME B&PV Code, Section VIII, and thermal stresses were evaluated using the rules of the ASME B&PV Code, Section III, Subsection NE.

TABLE 9.5.4-2

SINGLE FAILURE ANALYSIS FOR DIESEL GENERATOR FUEL OIL SYSTEM

Component	Malfunction	Comments and Consequences
Fuel Oil Storage Tank	Rupture	The redundant system (i.e. Train A and B) is capable of tolerating the passive failure of one fuel oil storage tank due to the fact that the redundant diesel generator is not supplied from the same tank.
Fuel Oil Transfer Pump	Pump fails to start	Fuel transfer capability to one diesel generator will be lost. Since redundant, independent diesel generator trains are provided the failure of any component in one train will not preclude the availability of at least one diesel.
	Pump fails to stop	Day Tank hi-hi level signal closes solenoid inlet valve to prevent overflow.
Fuel Oil Transfer Piping	Piping Rupture	Same as pump fails to start.
Fuel Oil Transfer Valves	Valves fail to open	Same as pump fails to start.
Fuel Oil Day Tank	Rupture	Same as pump fails to start.

TABLE 9.5.5-1

DESIGN PARAMETERS FOR DIESEL GENERATOR COOLING WATER SUBSYSTEM

Standpipe		
Capacity, gal.	733	
Engine Driven Jacket Water Pump		
Flow, gpm	1550	
Total dynamic head, ft.	48.5	
Jacket Water Keep Warm Heater		
Power, KW	75	
Voltage, v	480 V AC	
Jacket Water Cooler		
Quantity	1	
	Shell	Tube
Flow, gpm	1550	800
Discharge pressure, psig	75	75
Temperature, Inlet, F	175	95
Temperature, Exit, F	157	130
Code	ASME Section III	
	TEMA Class R	

TABLE 9.5.6-1

DESIGN DATA - DIESEL ENGINE STARTING SYSTEM COMPONENTS

Air Compressor	
Quantity	2
Type	Two Stage Piston
Capacity, acfm	88
Discharge pressure, psig	250
Discharge temperature, F	140 Approx.
Speed, rpm	790
Code	
Driver	
Type	Electric AC Motor
Motor Rating	30 HP, 3 Phase, 460V AC, 60 Hz
Air Dryer	
Quantity	2
Type	Heaterless Desiccant Dryer
Flow rate, scfm	76.1
Pressure operating/design, psig	0-275 Operating/275 Design
Temperature operating/design, F	70-140 Operating/300 Design
Drying Chambers, quantity	2
Desiccant	Activated Alumina
Dew Point	5°F
Air Receiver	
Quantity	2
Type	Vertical-cylinder with Dished Head
Capacity, cu. ft.	305
Diameter, in.	60
Height, ft.	18-3/4 approx. (including lifting eyes)
Design pressure, psig	300
Design temperature, F	250
Material	SA 515, Gr 70, Shell and Heads
Code	ASME Section III Code, Class 3
Piping	
Between Compressor & Dryer:	
Pressure, operating/design, psig	250/275
Temperature, operating/design, F	140/150
Material	ASME SA-106 Gr. B
Between Dryer & Receiver, Receiver & Engine:	
Pressure, operating/design, psig	250/275
Temperature, operating/design, F	140/150
Material	ASME SA-106 Gr. B

Table 9.5.6-1 (Continued)

Valves

Between Dryer & Receiver, Receiver & Engine:

Pressure, design, psig (minimum)	300
Temperature, design, F (minimum)	200
Material	SA351-CF8M

TABLE 9.5.7-1

DESIGN PARAMETERS FOR DIESEL GENERATOR LUBE OIL SYSTEM COMPONENTS

Engine Driven Lube Oil Pump		
Type	Screw	
Flow, gpm	500	
Discharge Pressure, psig	50	
Lube Oil Keep Warm Pump		
Type	Positive Displacement, Screw	
Flow, gpm	99	
Discharge Pressure, psig	20	
Motor Rating	7.5 HP, 3 Phase, 480V AC, 60 Hz	
Speed, rpm	1800	
Motor Driven Auxiliary Lube Oil Pump		
Type	Positive Displacement, Screw	
Flow, gpm	575	
Discharge Pressure, psig	85	
Motor Rating	60 HP, 3 Phase, 480V AC, 60 Hz	
Speed, rpm	1200	
Lube Oil Heater (Lube Oil Prelube Electric Heater)		
Quantity	1	
Power, kW	50	
Voltage, V	480 V AC	
Lube Oil Coolers		
Quantity	1	
	Shell	Tube
Flow, gpm	500	800
Discharge Pressure, psig	75	75
Temperature, Inlet F	185	152
Temperature, Exit F	158.7	160.4
Lube Oil Strainer		
Quantity	3	
Pressure, psig	100 (Operating)	
Flow, gpm	500	
Temperature, F	148	
Lube Oil Filter, Full Flow		
Quantity	1 Duplex	
Pressure, psig	100 (Operating)	
Flow, gpm	500	
Temperature, F	200	
Filtration	10 Micron	

Table 9.5.7-1 (Continued)

<u>Lube Oil Valves</u>	
a. 3-way plug	
Pressure, psig	100 ± 10% (Operating)
Temperature, F	185
b. Check	
Pressure, psig	150
Temperature, F	185
Code	ANSI - B16.1
c. Ball	
Pressure, psig	0 - 50 ± 10% (Operating)
Temperature, F	185

TABLE 9.5.7-2 ANNUNCIATION FOR THE DIESEL ENGINE LUBRICATION OIL SYSTEM

Instrument Number*	Service	Location	Description
PS-25C	Low Lube Oil Pressure	Engine Control Panel	Annunciates on the Diesel Engine Control Panel and redundant annunciation appears on the Annunciator Light Box on the Main Control Board. This alarm annunciates on the MCB under a trouble signal. The alarm is actuated when falling lube oil pressure reaches a set value of 40 psig.
PS-42C	Low Lube Oil Pressure Trip	Engine Control Panel	Annunciates on the Diesel Engine Control Panel and redundant annunciation appears on the Annunciator Light Box on the Main Control Board. This alarm annunciates when the diesel generator trips on low lube oil pressure. Annunciation will appear under the "Generator Trip" window. The trip is actuated when falling lube oil pressure reaches 30 psig.
N/A	Low Lube Oil Temperature IN/OUT		Annunciates on the Diesel Engine Control Panel and redundant annunciation appears on the Annunciator Light Box on the Main Control Board. This alarm annunciates on the MCB under the annunciator window for generator trouble. The alarm is actuated when the lube oil temperature in reaches 140°F falling or temperature out reaches 140°F falling.
N/A	High Lube Oil Temperature IN/OUT		Annunciates on the Diesel Engine Control Panel and redundant annunciation appears on Annunciator Light Box on the Main Control Board. This alarm annunciates on the MCB under the "Generator Trouble" annunciator window. The alarm is actuated when the lube oil temperature reaches a high temperature value of 175°F rising (in) and 190°F rising (out).
PS-16C	High Lube Oil Temperature Trip	Mounted on Engine	Annunciates on the Diesel Engine Control Panel and redundant annunciation appears on the Annunciator Light Box on the MCB. This alarm annunciates under the "Generator Trip" annunciator window. The trip is actuated when the lube oil temperature reaches a high temperature value of 195°F and rising.
ΔP-4	High Differential Pressure Across Filter	Engine Control Panel	Annunciates on the Diesel Engine Control Panel and redundant annunciation appears on the Annunciator Light Box on the MCB. This alarm annunciates under the "Generator Trouble" annunciator window. The alarm is actuated when the differential pressure across the filter reaches 20 psig and rising.
ΔP-1	High Differential Pressure Across Strainer	Engine Control Panel	Annunciates on the Diesel Engine Control Panel and redundant annunciation appears on the Annunciator Light Box on the MCB. This alarm annunciates under the "Generator Trouble" annunciator window. This alarm is actuated when the differential pressure across the strainer reaches 20 psig and rising.
LS-2	Low Lube Oil Level in the Sump	Engine Control Panel	Annunciates on the Diesel Engine Control Panel and redundant annunciation appears on Annunciator Light Box on the MCB. This switch annunciates under the "Generator Trouble" annunciator window. The alarm is actuated on low sump level.

TABLE 9.5.7-2 ANNUNCIATION FOR THE DIESEL ENGINE LUBRICATION OIL SYSTEM

Instrument Number*	Service	Location	Description
PS-20C/PS-43C	Low Turbocharger Oil Pressure left/right	Engine Control Panel	Annunciates on the Diesel Engine Control Panel and redundant annunciation appears on the Annunciator Light Box on the MCB. This alarm annunciates on the MCB. This alarm annunciates on the MCB under the "Generator Trouble" annunciator window. Pressure setting for alarm actuation is 20 psig falling left/right respectively.
PS-19C	Low Turbocharger Oil Pressure Trip	Engine Control Panel	Annunciates on the Diesel Engine Control Panel and redundant annunciation appears on Annunciator Light Box on the MCB. This alarm annunciates under the "Generator Trip" annunciator window. The trip is actuated when the turbocharger oil pressure reaches a low value of 15 psig and falling.
N/A	Auxiliary Lube Oil Pump	Engine Control Panel	Annunciates on the Diesel Engine Control Panel and redundant annunciation appears on the Annunciator Light Box on the MCB. Status lights indicate pump activity (start - red, stop - green, auto - amber). The alarm for the auxiliary lube oil pump operation will appear under the "Generator Trouble" annunciator window.
PS-27C	High Crankcase Pressure Trip	Engine mounted	Annunciates on the Diesel Engine Control Panel and redundant annunciation appears on the Annunciator Light Box on the MCB. The alarm for high crankcase pressure is annunciated under the "Generator Trip" annunciator window. The trip is actuated when the crankcase pressure reaches 2.5 psig and rising.

FIGURE 9.1.1-1

PWR FUEL RACK

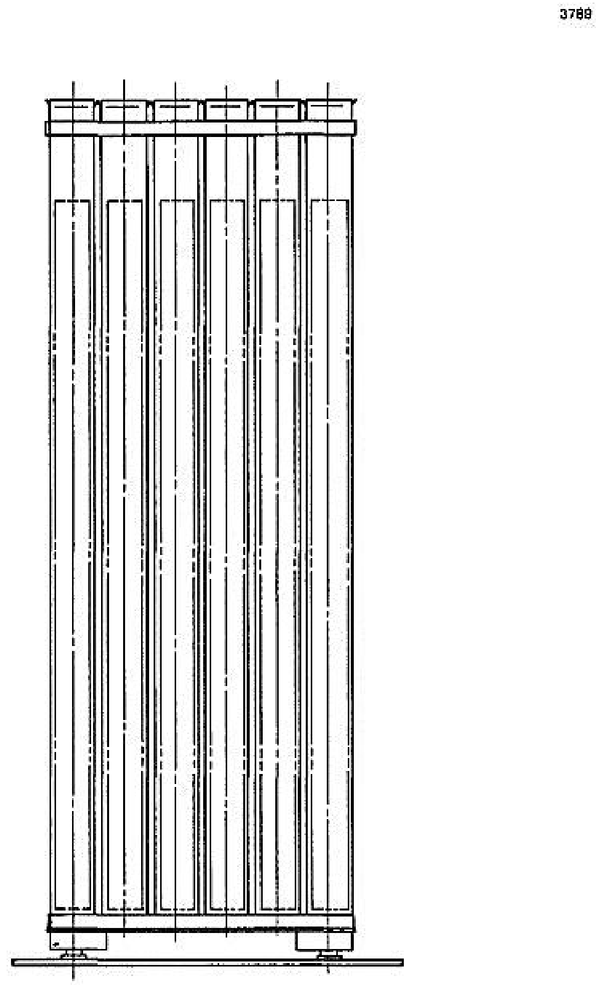


FIGURE 9.1.1-2

BWR FUEL RACK

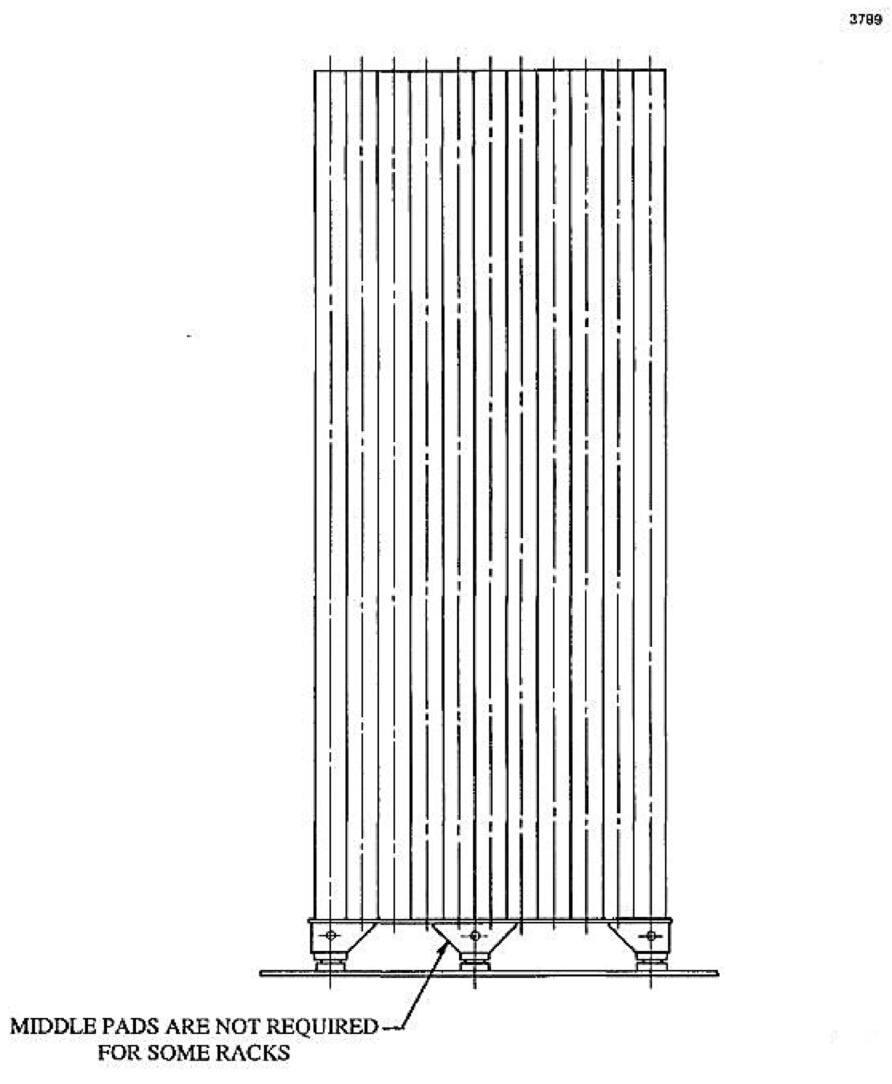


FIGURE 9.1.2-1

ALLOWED LOCATIONS FOR NFBC IN 2-OF-4 REGION

Allowed locations for NFBC in 2-of-4 Region

F		F		F		F		F	
	F	TB	F		F	TB	F		F
F		F		F		F		F	
TB	F		F	TB	F		F	TB	F
F		F		F		F		F	
	F	TB	F		F	TB	F		F

F									
TB	F								
F									
	F	TB							
F									
TB	F								

F- Fuel Assembly
TB - NonFuel Bearing Component

FIGURE 9.1.2-2

ACCEPTABLE ARRANGEMENTS IN RESTRICTED (2-OF-4 STORAGE)

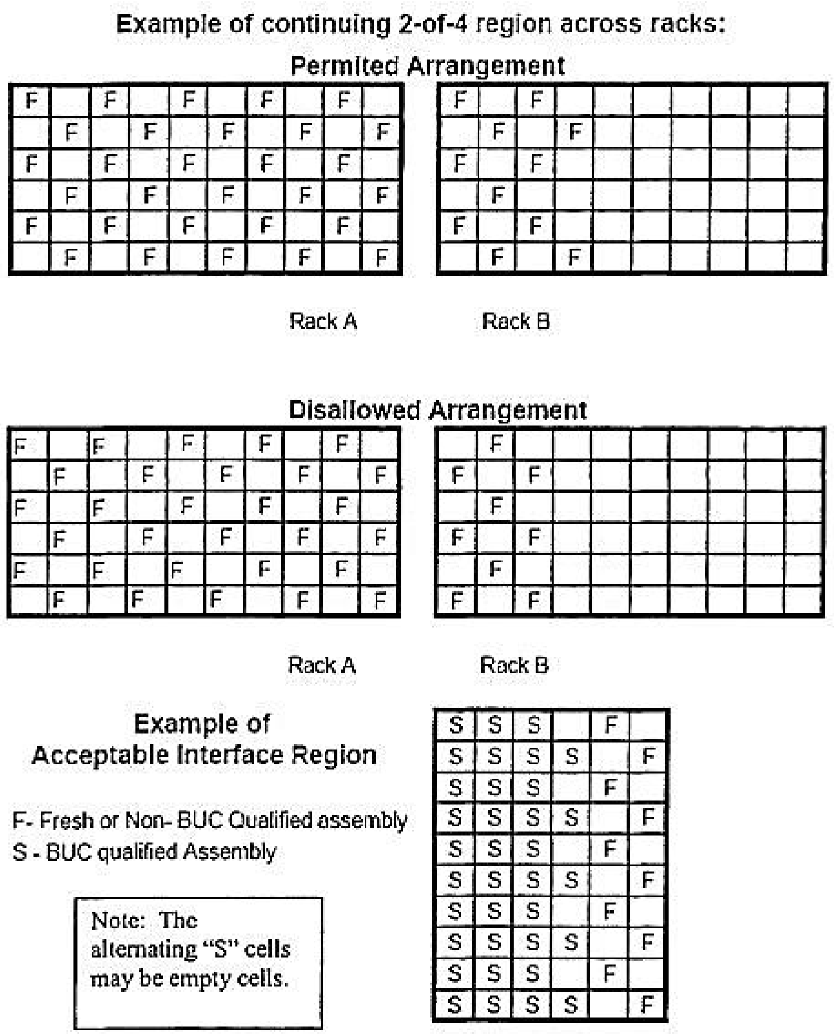


FIGURE 9.1.4-1

REACTOR INTERNALS LIFTING DEVICE

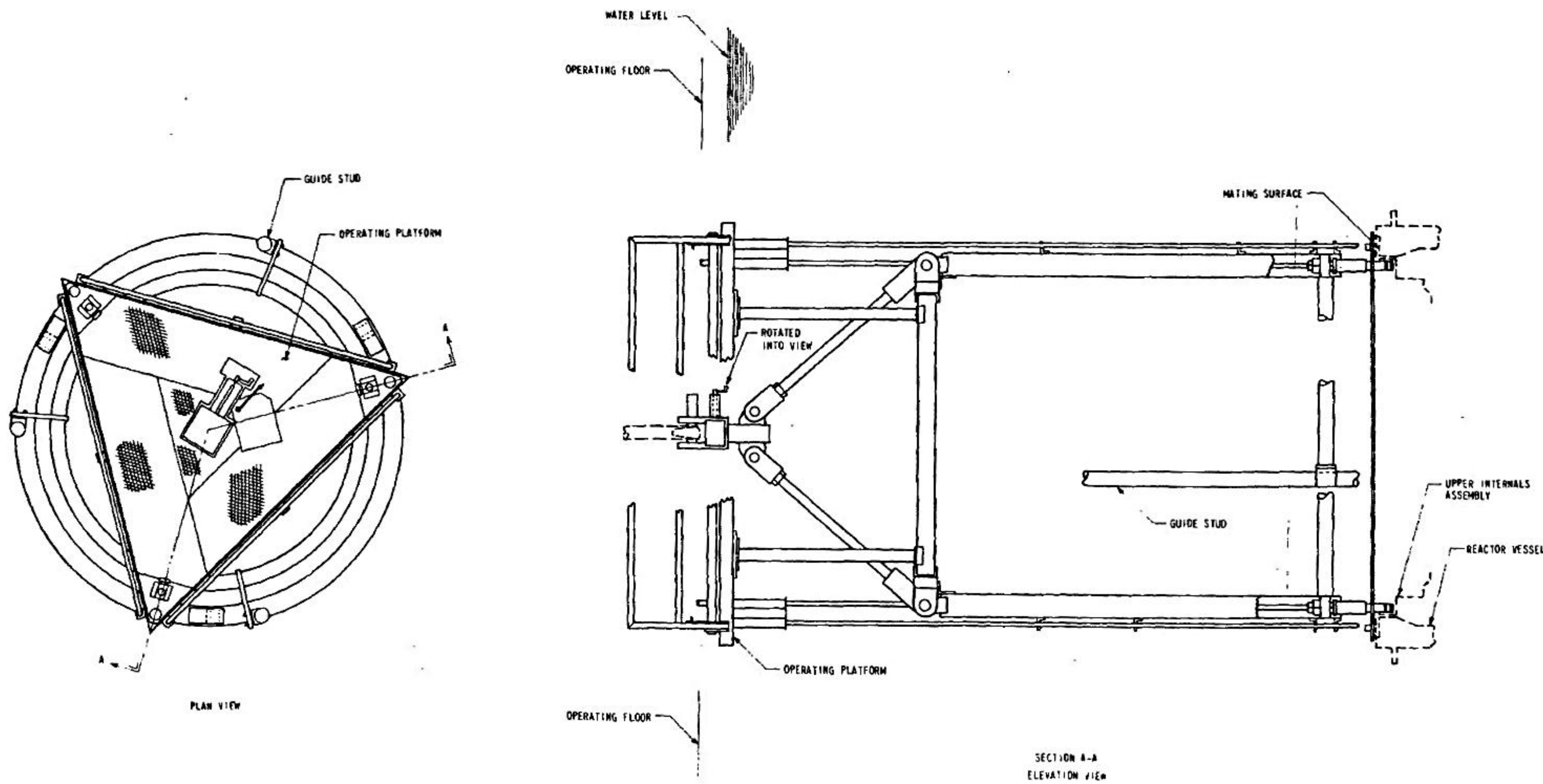


FIGURE 9.1.4-2

MANIPULATOR CRANE

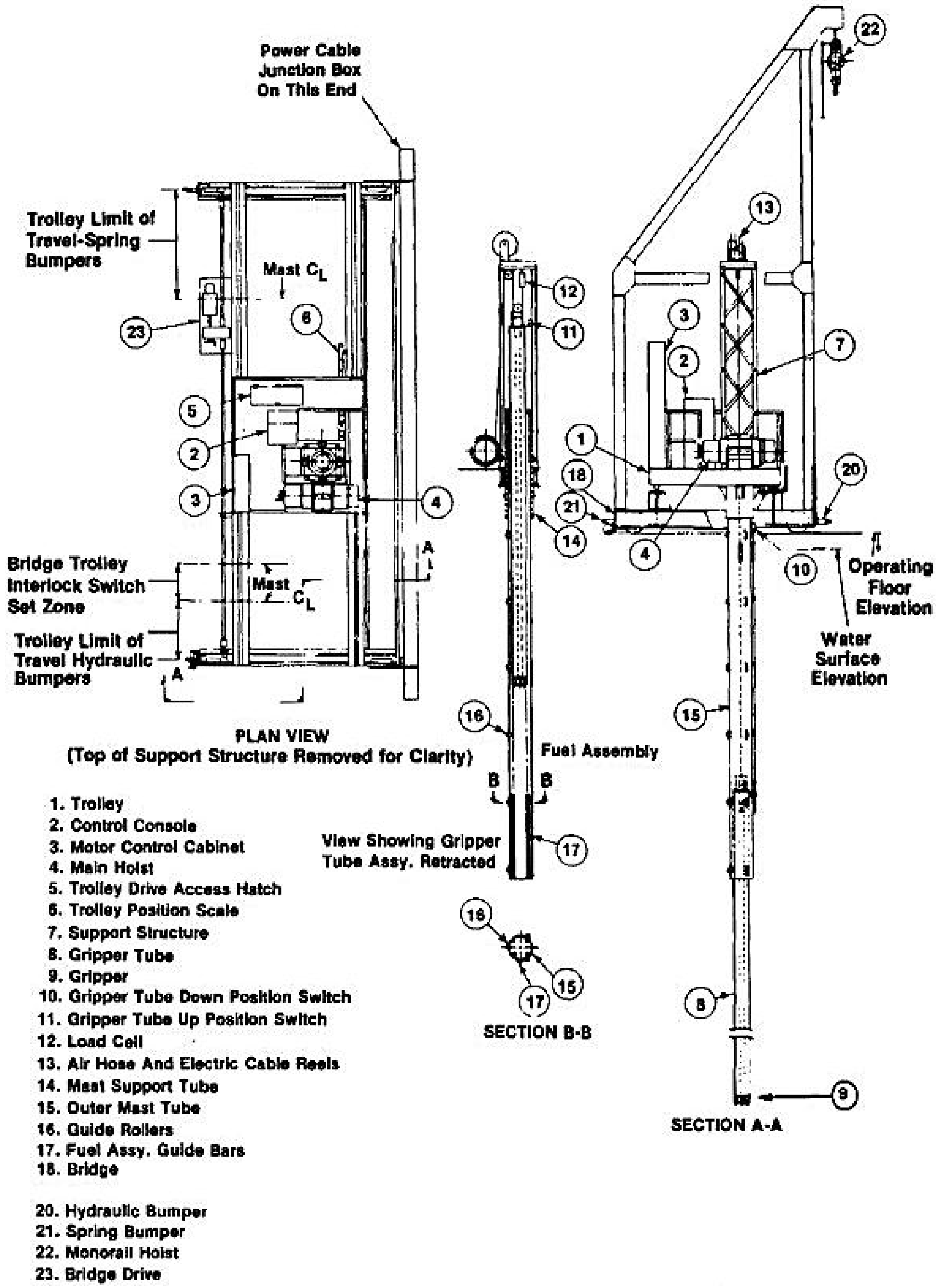


FIGURE 9.1.4-3

SPENT FUEL BRIDGE CRANE

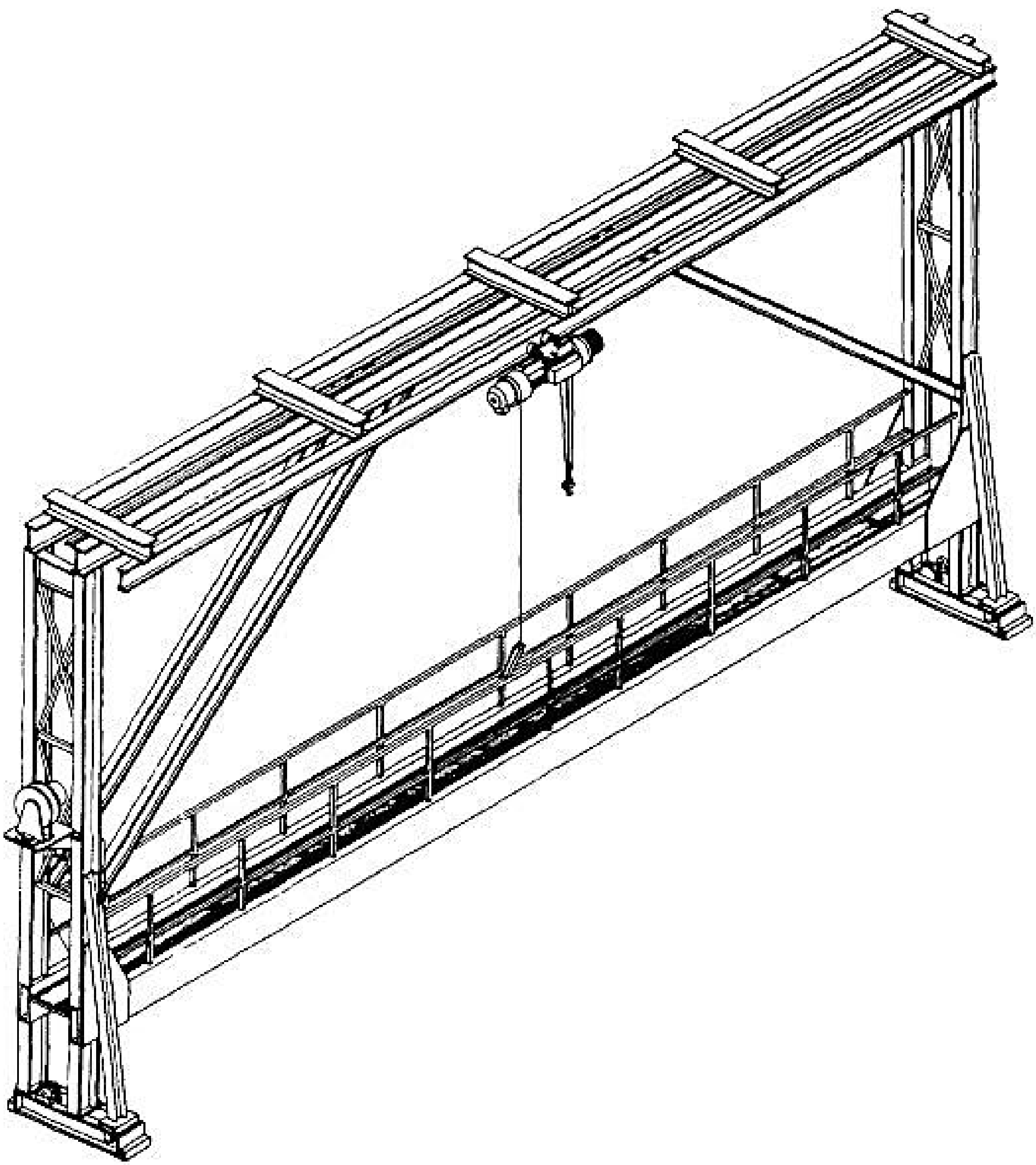


FIGURE 9.1.4-4

PWR LONG HANDLED TOOL

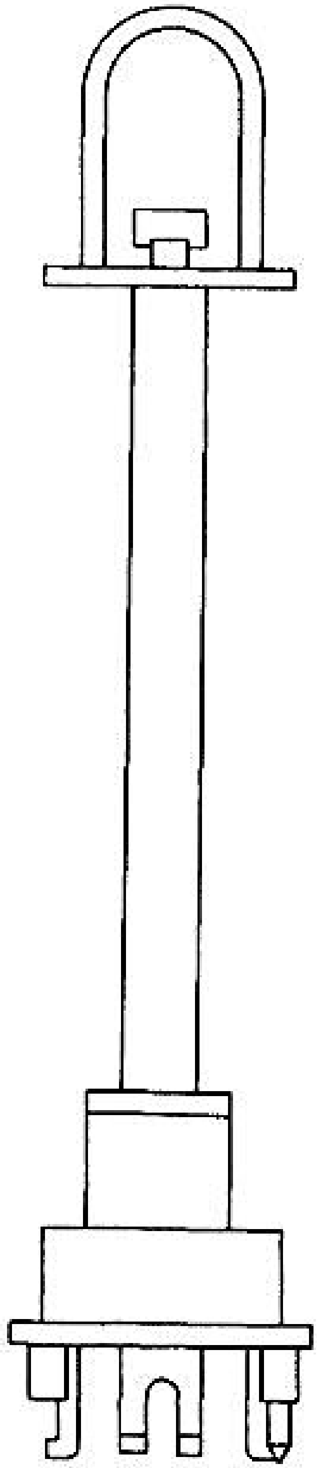


FIGURE 9.1.4-4a

PWR LONG HANDLED TOOL

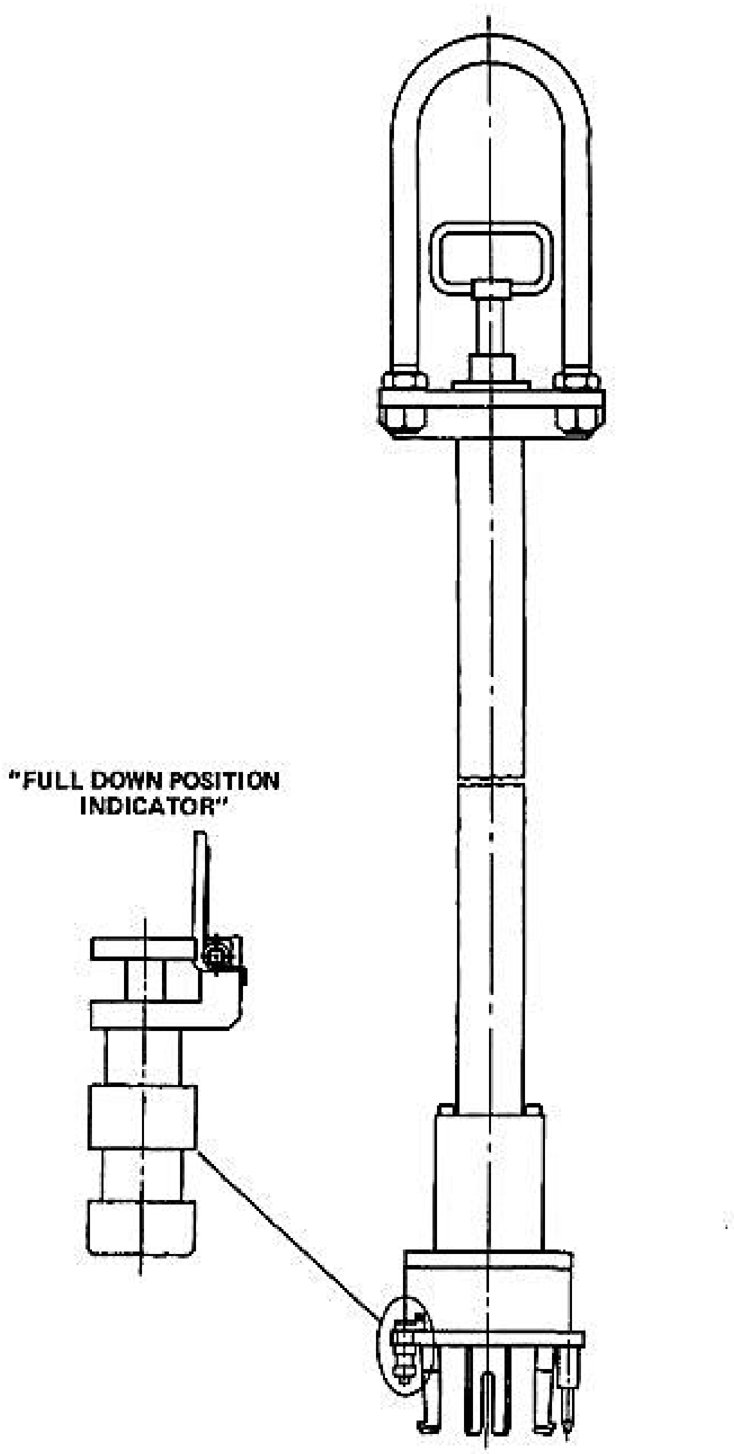


FIGURE 9.1.4-6

ROD CLUSTER CONTROL CHANGE FIXTURE

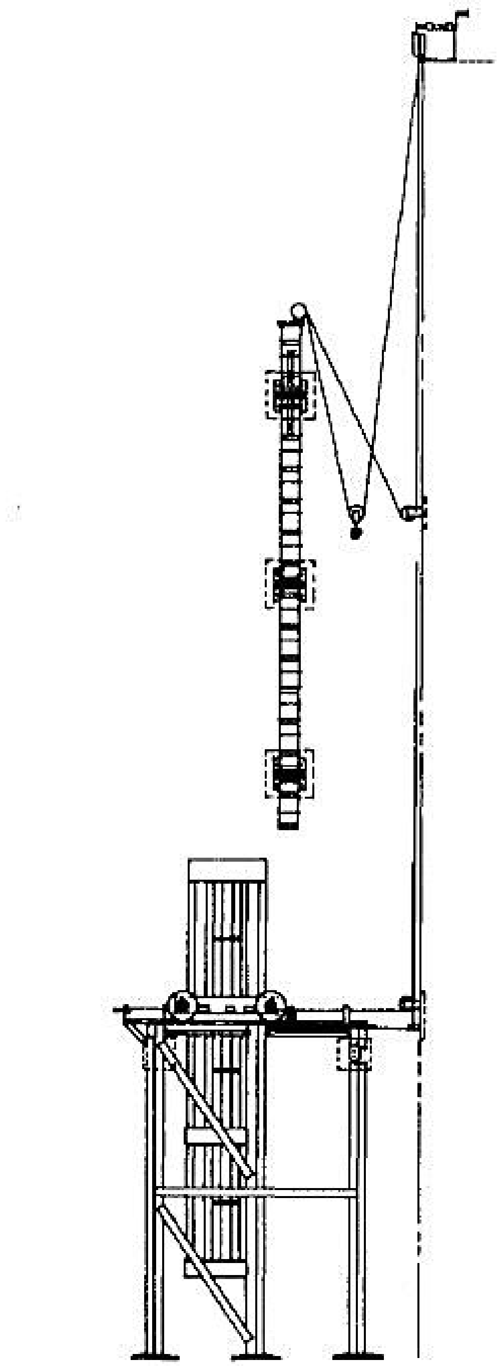


FIGURE 9.1.4-7

SPENT FUEL CASK CRANE MAIN HOOK AND CASK TRAVEL ENVELOPES - SHEET 1

Security-Related Information - Figure Withheld Under 10 CFR 2.390

FIGURE 9.1.4-8

SPENT FUEL CASK CRANE MAIN HOOK AND CASK TRAVEL ENVELOPES - SHEET 2

Security-Related Information - Figure Withheld Under 10 CFR 2.390

FIGURE 9.1.4-9

SPENT FUEL CASK CRANE MAIN HOOK AND CASK TRAVEL ENVELOPES - SHEET 3

Security-Related Information - Figure Withheld Under 10 CFR 2.390

FIGURE 9.1.4-10

SPENT FUEL CASK CRANE MAIN HOOK AND CASK TRAVEL ENVELOPES - SHEET 4

Security-Related Information - Figure Withheld Under 10 CFR 2.390

FIGURE 9.1.4-11

SPENT FUEL CASK CRANE MAIN HOOK AND CASK TRAVEL ENVELOPES - SHEET 5

Security-Related Information - Figure Withheld Under 10 CFR 2.390

FIGURE 9.1.4-12

SPENT FUEL CASK CRANE MAIN HOOK AND CASK TRAVEL ENVELOPES - SHEET 6

Security-Related Information - Figure Withheld Under 10 CFR 2.390

FIGURE 9.1.4-13

PWR SHORT HANDLING TOOL

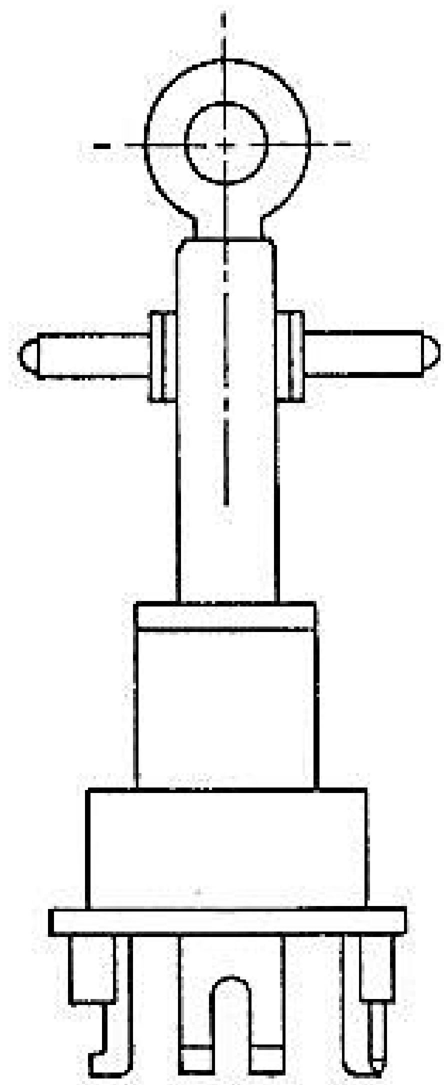


FIGURE 9.2.6-1

CONDENSATE STORAGE TANK

Security-Related Information - Figure Withheld Under 10 CFR 2.390

FIGURE 9.2.8-1

ESSENTIAL SERVICES CHILLED WATER FLOW DIAGRAM

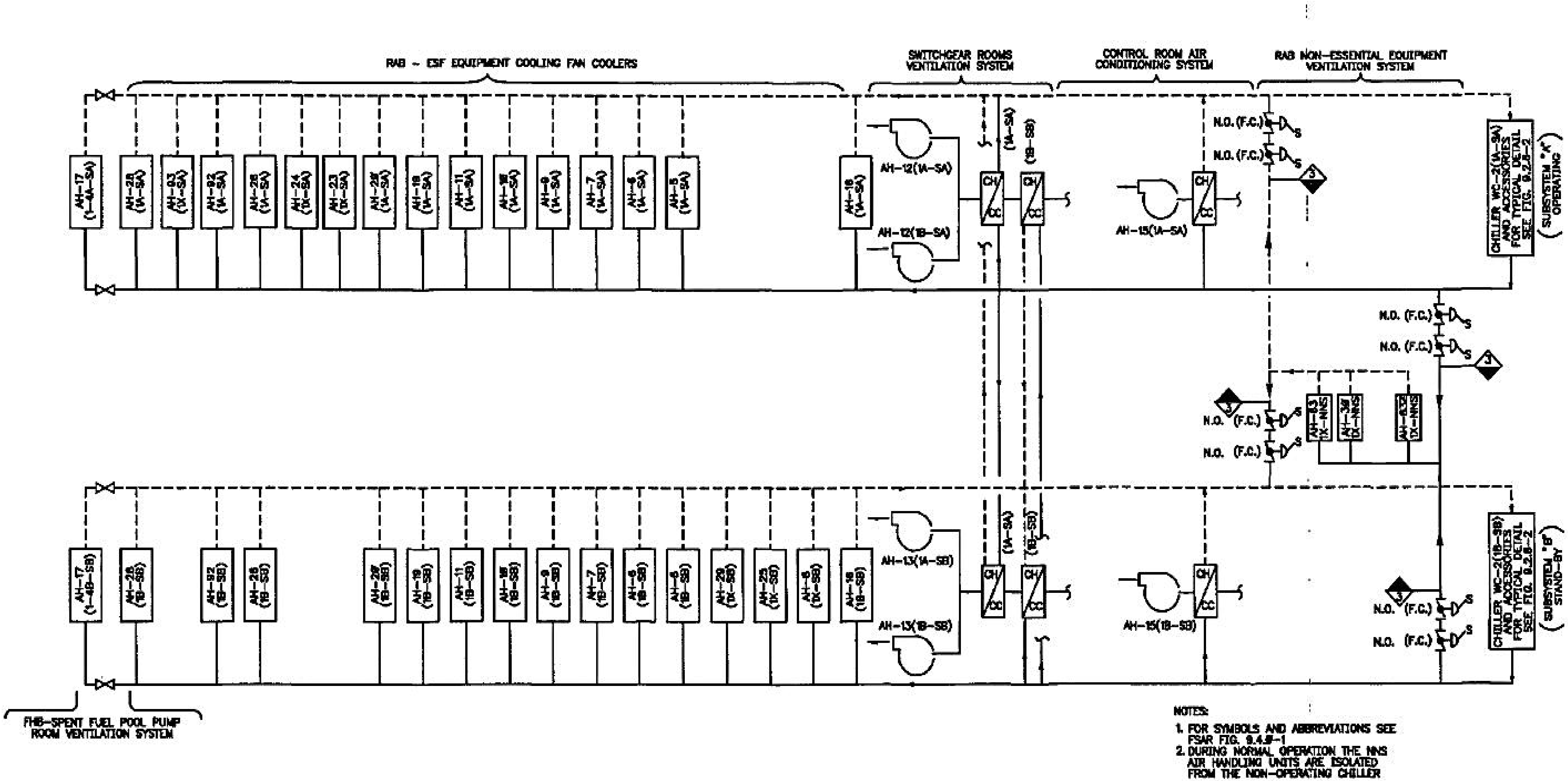


FIGURE 9.2.8-2

ESSENTIAL SERVICES CHILLED WATER CHILLERS, FLOW RATES AND MISCELLANEOUS DETAILS

Security-Related Information - Figure Withheld Under 10 CFR 2.390

FIGURE 9.3.4-5

CHEMICAL AND VOLUME CONTROL SYSTEM

Security-Related Information - Figure Withheld Under 10 CFR 2.390

FIGURE 9.3.6-1

GROSS FAILED FUEL DETECTOR ELECTRONICS DIAGRAM

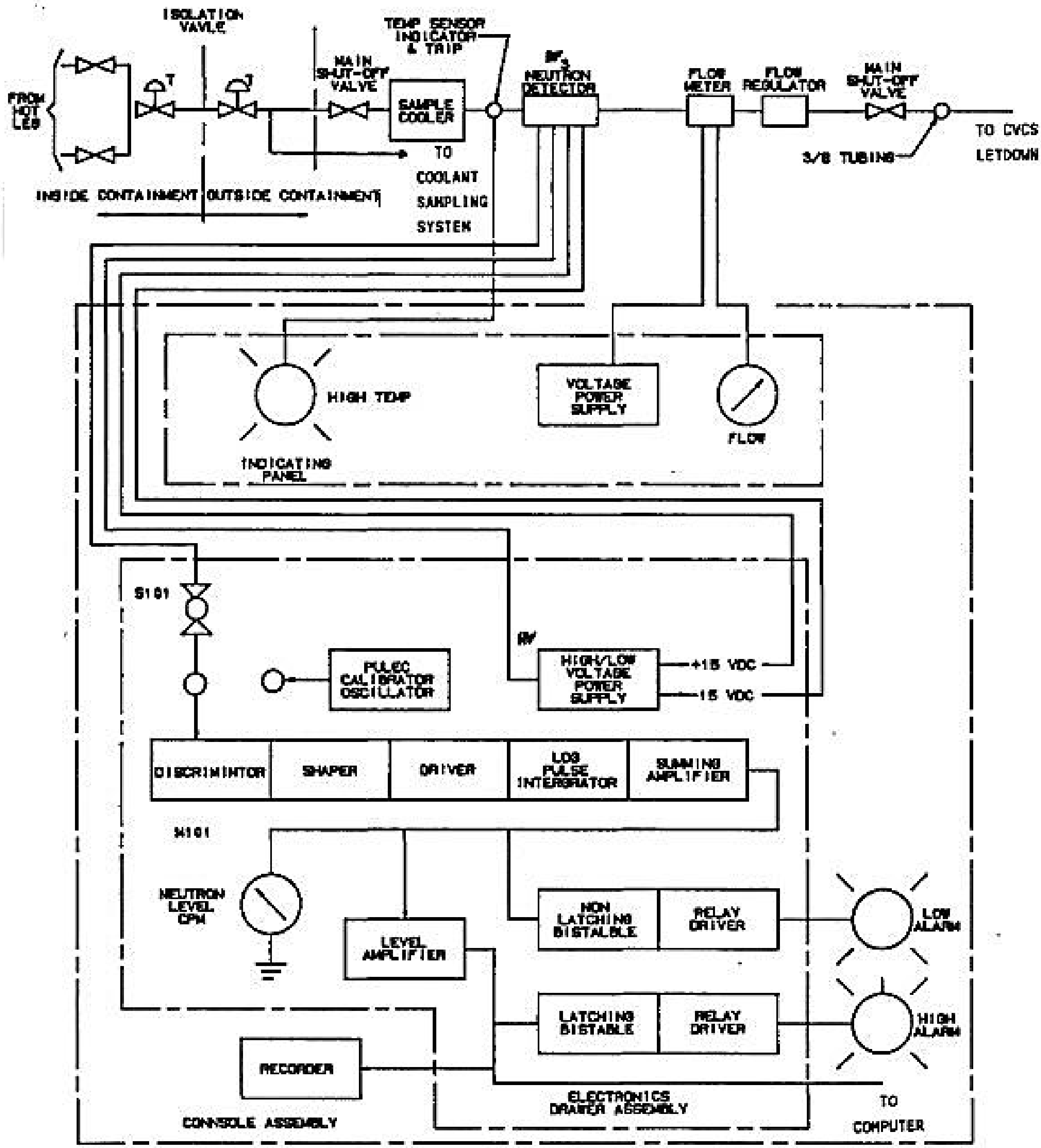


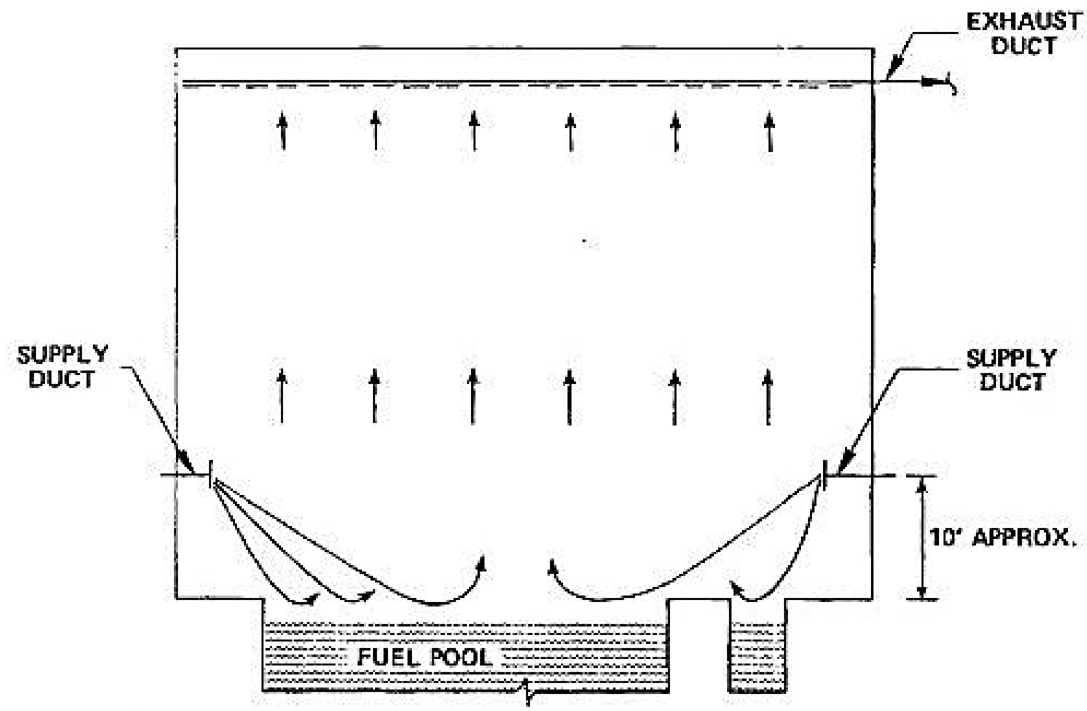
FIGURE 9.4.0-2

PLANT AIRBORNE EFFLUENT RELEASE POINTS AND OUTSIDE AIR INTAKES

Security-Related Information - Figure Withheld Under 10 CFR 2.390

FIGURE 9.4.2-2

HVAC FUEL POOL VENTILATION SYSTEM



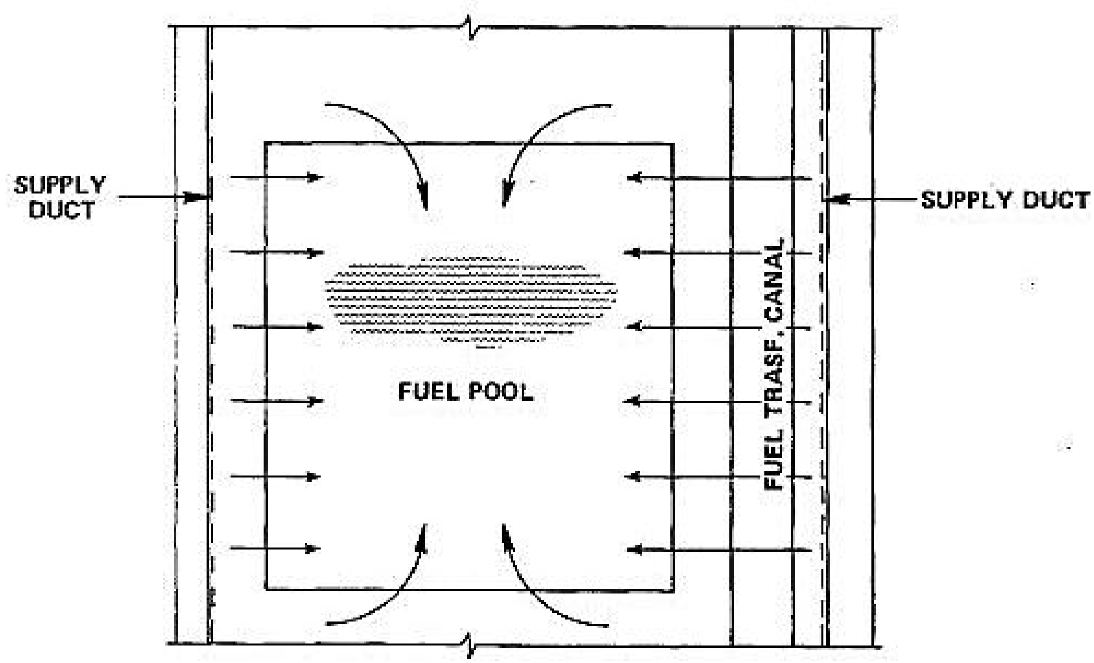


FIGURE 9.5.2-1

TELEPHONE SYSTEM – BLOCK DIAGRAM

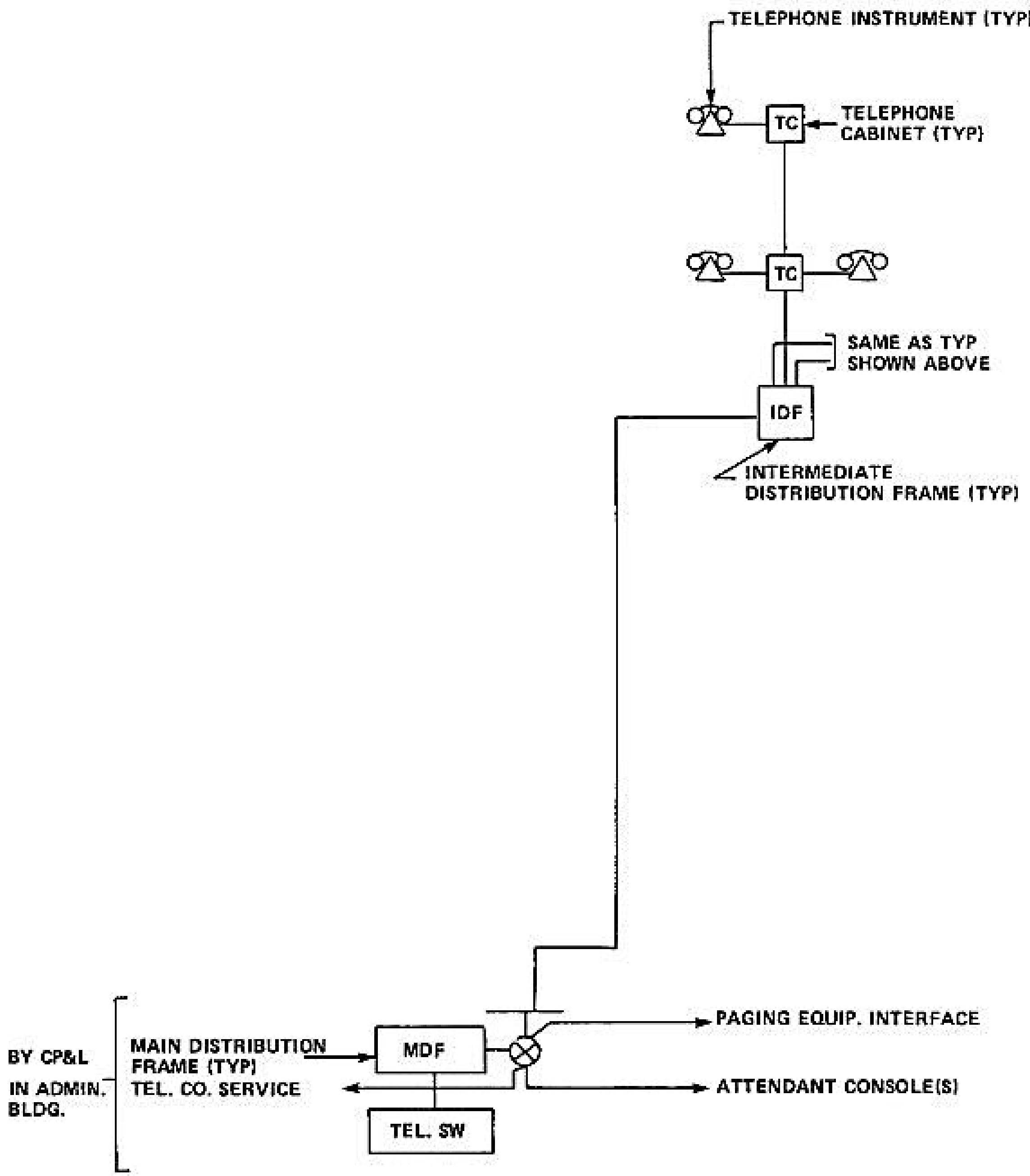


FIGURE 9.5.2-2

PAGING SYSTEM – BLOCK DIAGRAM

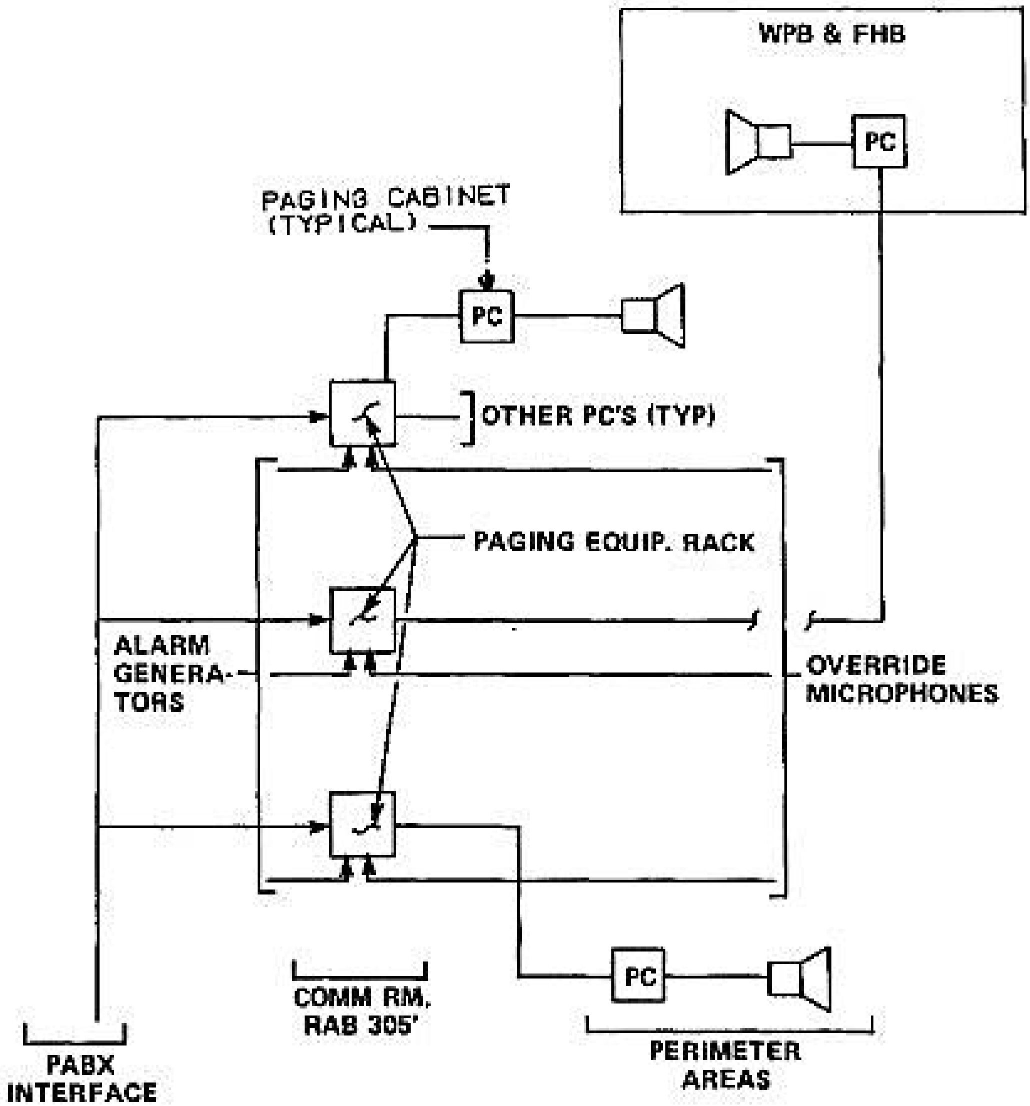
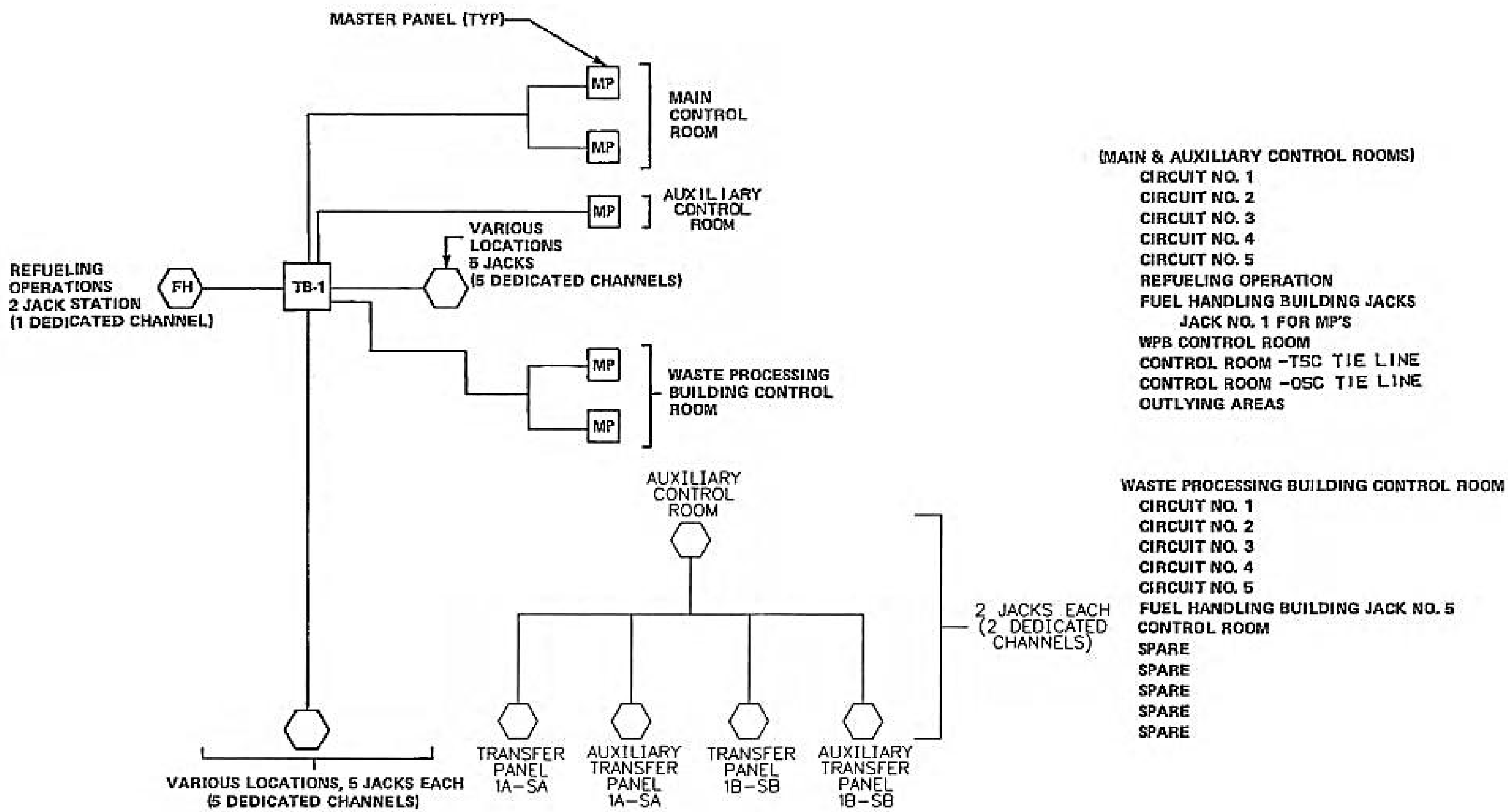


FIGURE 9.5.2-3

SOUND POWERED SYSTEM – BLOCK DIAGRAM



NOTE:
1) FOR CIRCUIT ALLOCATIONS TO MASTER PANELS SEE ATTACHED SUMMARY.

FIGURE 9.5.2-5

INSIDE BUILDINGS RADIO SIGNAL DISTRIBUTION SYSTEM BLOCK DIAGRAM, ELEVATION 261'-0"

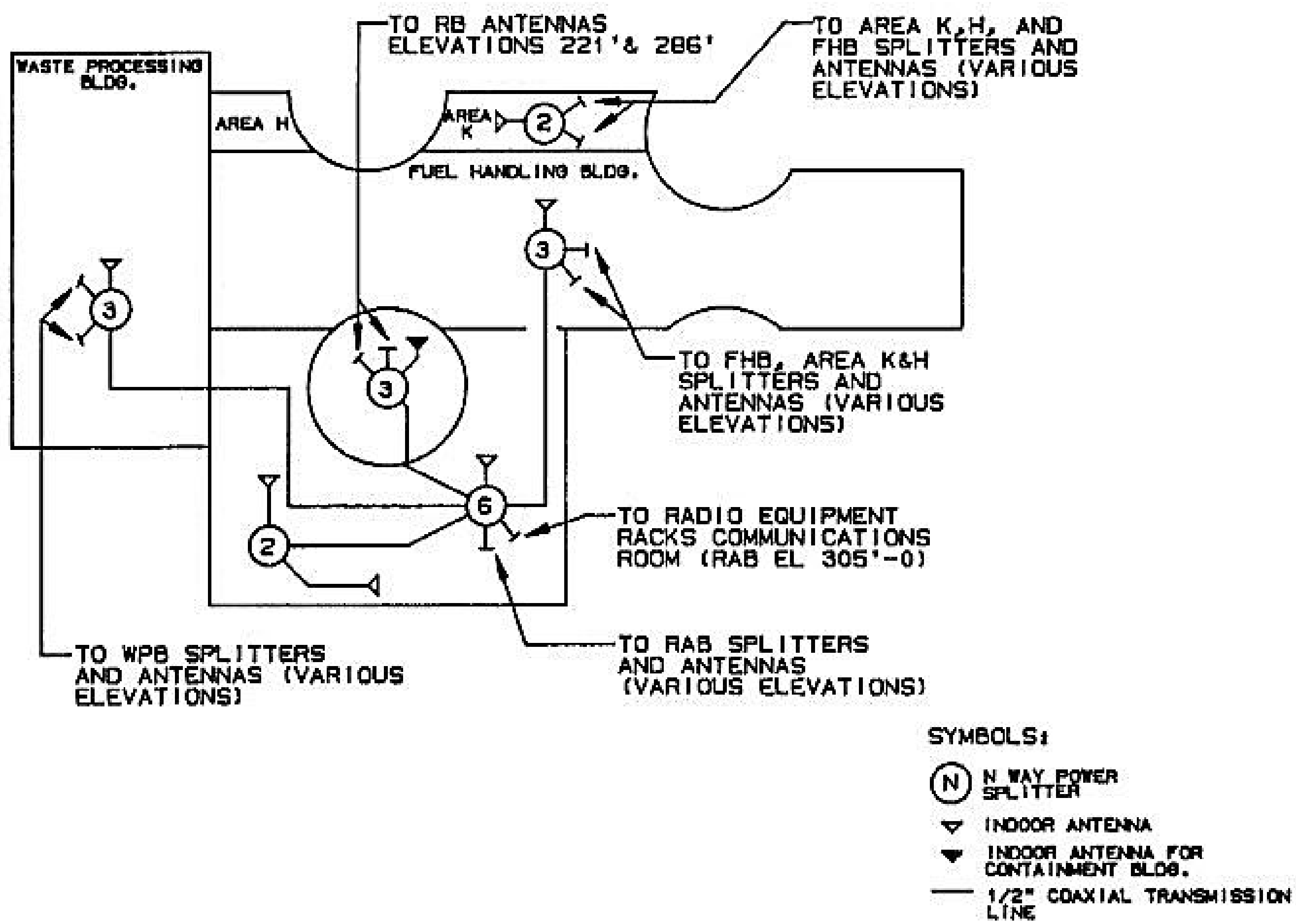


FIGURE 9.5.2-6

POWER SUPPLY FOR SHNPP PABX AND SOUTHERN BELL

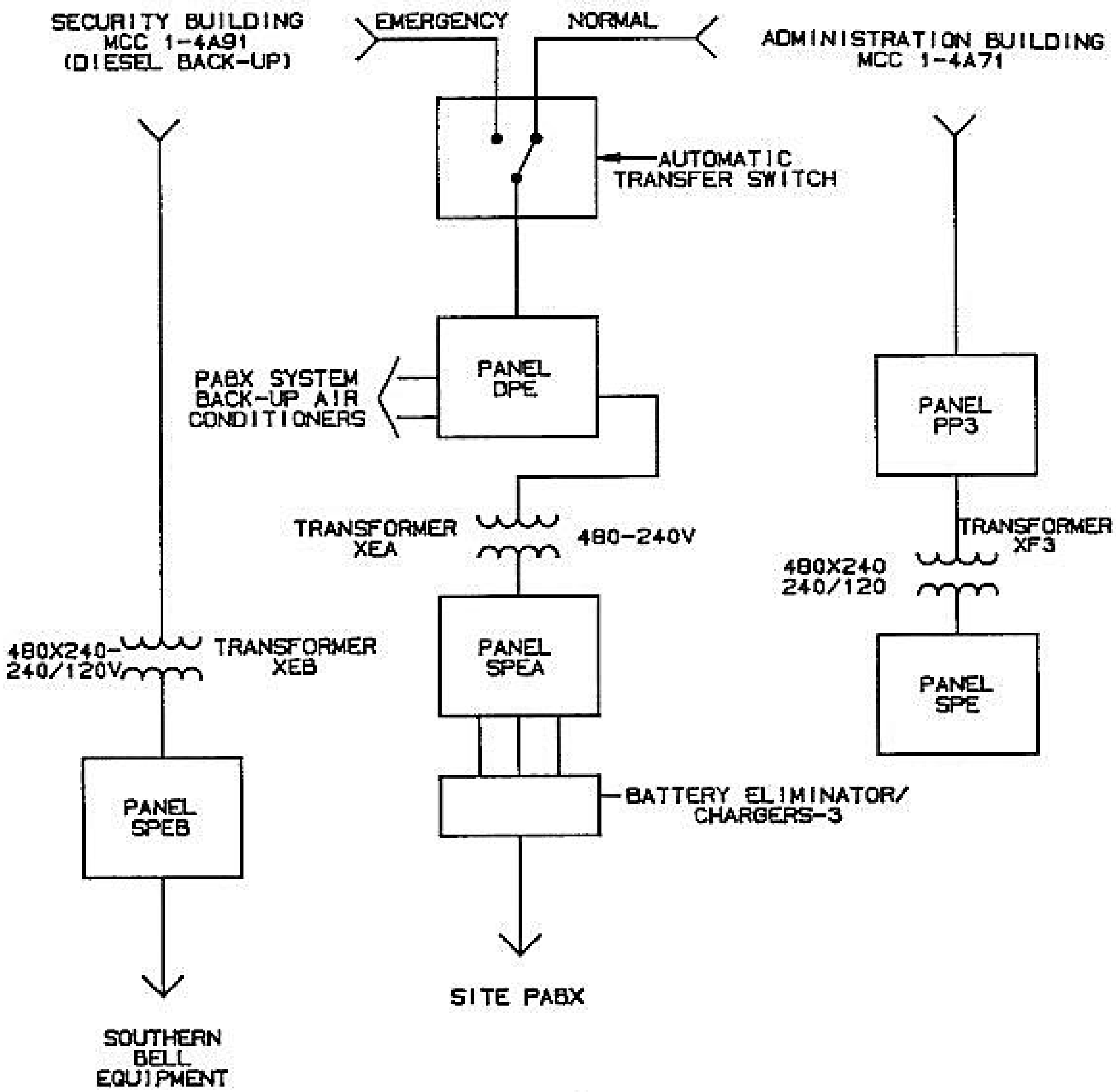
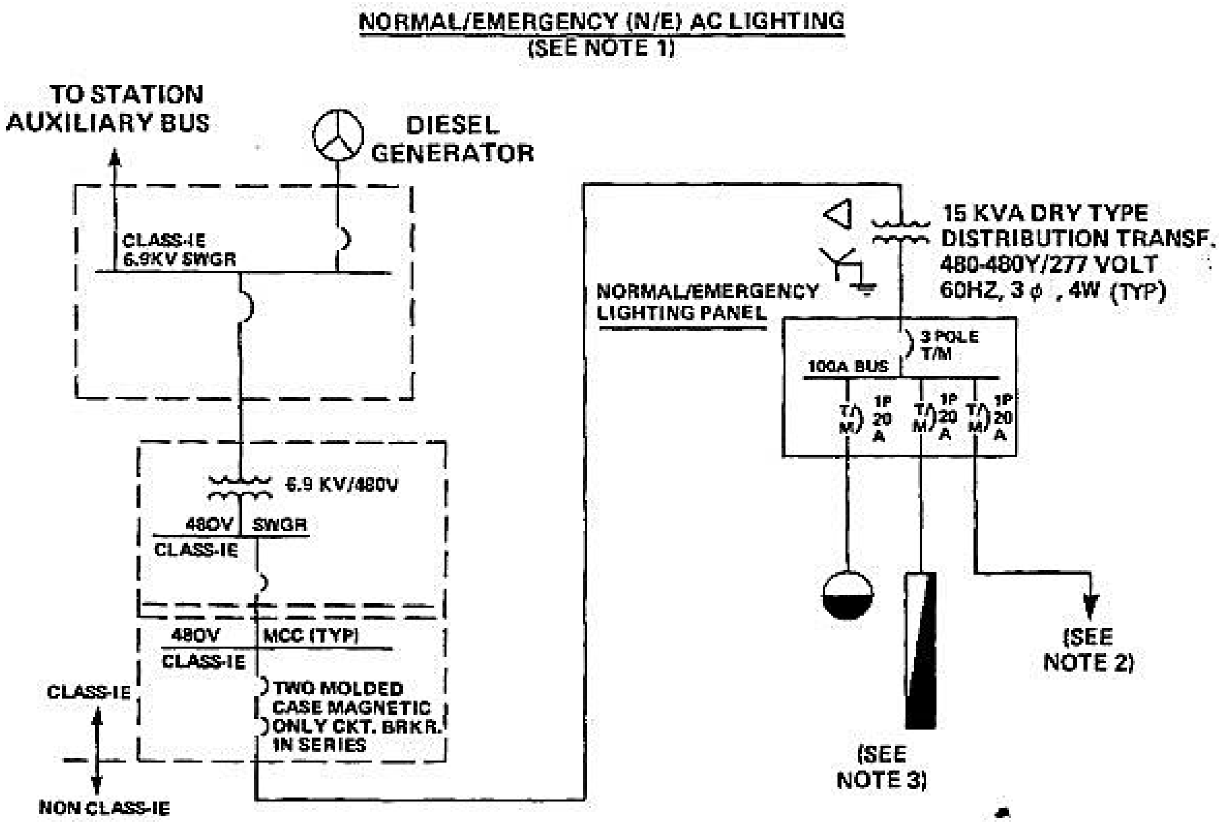


FIGURE 9.5.3-1

PLANT LIGHTING



NOTES:

1. CONFIGURATION SHOWN IS TYPICAL FOR EACH SAFETY TRAIN A OR B REDUNDANT LIGHTING CONDUITS ARE SEPARATED AND INDEPENDENTLY SUPPORTED. THE FAILURE OF ONE REDUNDANT TRAIN WILL NOT JEOPARDIZE THE OPERATION OF THE OTHER TRAIN OR ANY SAFETY RELATED CIRCUIT

2. TO CONTACTOR IN D.C. EMERGENCY LIGHTING PANELS 140 AND 142. LOSS OF A.C. POWER AT N/E PANEL AUTOMATICALLY ENERGIZES EMERGENCY DC LIGHTING SYSTEM

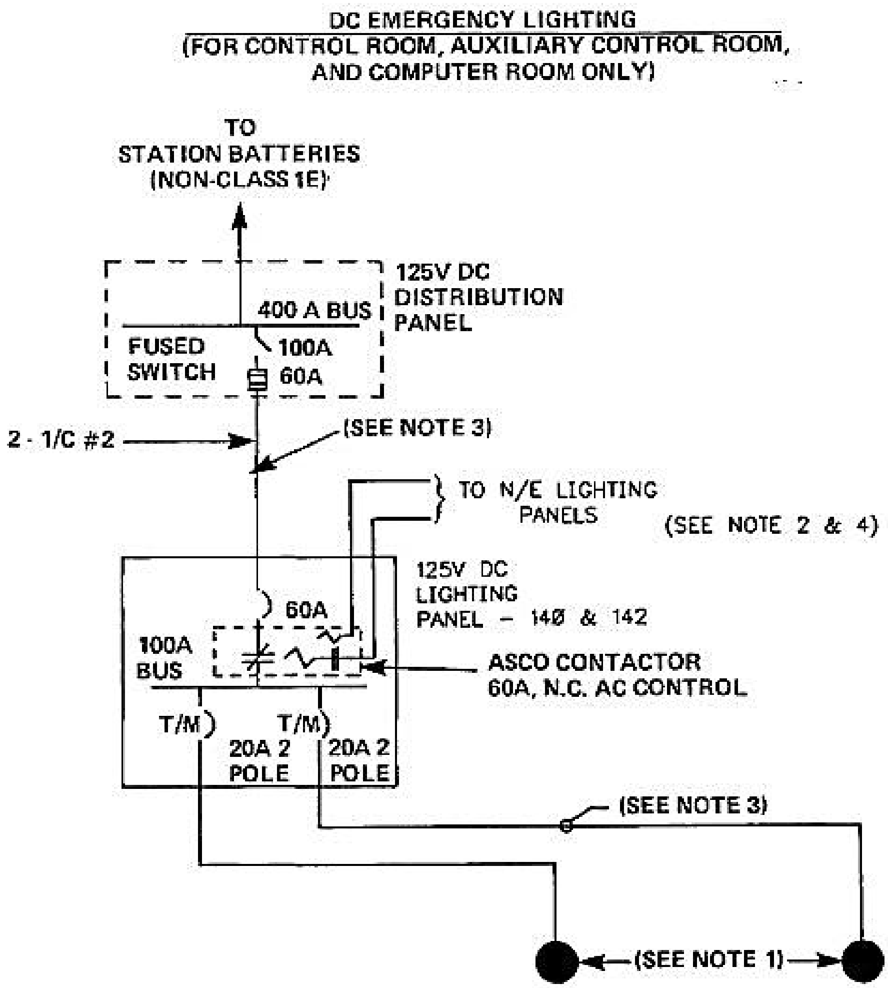
3. LIGHTING FOR N/E SYSTEM IS BY FLUORESCENT FIXTURES OR INCANDESCENT FIXTURES RATED FOR 120V OR 277V, 1φ OPERATION

LEGEND:

T/M – THERMAL MAGNETIC MOLDED CASE BREAKER

FIGURE 9.5.3-2

PLANT LIGHTING



NOTES

1. LIGHTING FOR DC EMERGENCY SYSTEM IS SUPPLIED BY INCANDESCENT FIXTURES
2. UPON LOSS OF POWER ON EITHER N/E TRAIN, DC EMERGENCY LIGHTING IS AUTOMATICALLY ENERGIZED
3. EMERGENCY LIGHTING CONDUITS ARE SEPARATED AND INDEPENDENTLY SUPPORTED FROM EITHER OF THE N/E TRAINS
4. THIS DRAWING IS A TYPICAL FUNCTIONAL REPRESENTATION OF THE CIRCUIT. LP-142 SUPPORTS ONLY TWO INCANDESCENT FIXTURES AND DOES NOT HAVE MOLDED CASE DISCONNECT.

LEGEND:

T/M - THERMAL MAGNETIC MOLDED CASE BREAKER