SECTION 9

AUXILIARY SYSTEMS

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont)

TABLE OF CONTENTS (Cont)

TABLE OF CONTENTS (Cont)

TABLE OF CONTENTS (Cont)

TABLE OF CONTENTS (Cont)

TABLE OF CONTENTS (Cont)

TABLE OF CONTENTS (Cont)

LIST OF TABLES

LIST OF TABLES (Cont)

LIST OF FIGURES

LIST OF FIGURES (Cont)

THIS PAGE INTENTIONALLY BLANK

LIST OF FIGURES (Cont)

SECTION 9

AUXILIARY SYSTEMS

The Auxiliary Systems are supporting systems required for safe operation and servicing of the Reactor and the Reactor Coolant System and Engineered Safeguards Systems.

9.1 FUEL STORAGE AND HANDLING

The Fuel Handling and Storage System provides a safe, effective means of storing, transporting and handling fuel from the time it reaches the plant in an unirradiated condition until it leaves the plant after post-irradiation cooling. Each unit has a completely independent Fuel Handling and Storage System. The following description is for Unit 1 with Unit 2 having an identical system.

The system is designed to minimize the possibility of mishandling or of maloperations that could cause fuel damage and potential fission product release.

9.1.1 New Fuel Storage

9.1.1.1 Design Bases

The new fuel assemblies are received and stored dry in racks in the new fuel storage area, located in the Fuel Handling Building (see Plant Drawing 204836). New fuel is delivered to the reactor by lowering it into the transfer pool and taking it through the transfer system. The new fuel storage area is sized for storage of the fuel assemblies and control rods normally associated with the replacement of one-third of a core.

9.1.1.2 Safety Evaluation

The new fuel storage racks have been designed in accordance with the 1963 AISC Code. Seismic loads as well as dead load of fuel assemblies are considered in the design. The new fuel storage racks are designed so that it is impossible to insert the assemblies in other than the prescribed locations. The 21-inch nominal spacing between fuel assemblies will maintain a subcritical array even if the pool is flooded with unborated demineralized water.

Adequate shutdown margin is maintained for 17 x 17 fuel with 4.65 w/o (5) enrichment and no Integral Fuel Burnable Absorbers (IFBA) present. For consistency with the Region I (Exxon) spent fuel storage rack requirements (where new fuel must be placed before loading the core), only up to 4.25 w/o enriched 17 x 17 fuel assemblies without IFBA are allowed to be stored in the new (dry) fuel storage racks. Unirradiated fuel assemblies with enrichments greater than 4.25 w/oU-235 and less than or equal to 5.0 w/o U-235 are acceptable for storage with credit for a minimum number of IFBA pins. This minimum number of IFBA pins shall have an equivalent reactivity hold-down which is greater than or equal to the reactivity hold-down associated with N IFBA pins, at a nominal 2.35 mg B-10/linear inch loading (1.5X), determined by the equation below:

$$N = 42.67(E - 4.25)$$

The above equation is based on a more restrictive IFBA requirement for the Region I spent fuel racks and is conservative for the new fuel racks. E in the equation above is the fresh assembly design enrichment. A potential optimum moderation condition is precluded in the new fuel storage area by the following design features.

1. The Fuel Handling Building has no fire fighting hose stations,

2. The Fuel Handling Building has no installed aqueous fire suppression systems (e.g., sprinklers, fog, or sprays),

3. New fuel is covered with a protective metal plate during storage which prevents the introduction of low density water into the fuel racks from above.

The only accessible fire fighting hoses available for use in the new fuel storage area are connected to hose stations in the auxiliary building and will be equipped with straight-stream nozzles.

9.1.2 Spent Fuel Storage

The spent fuel storage pool is the storage space for irradiated spent fuel from the reactor. This pool is not required for any plant safety-related function.

9.1.2.1 Design Bases

The Spent Fuel Pool reracking project implemented in 1994 increased the fuel storage capacity from 1170 fuel assemblies to 1632 fuel assemblies. The reracking project retained 3 existing high density Exxon Nuclear Corporation modules containing 300 cells (Region I) and added 9 new maximum density Holtec modules containing 1332 cells (Region II) with a total storage capacity of 1632 fuel assemblies. The reracking provided an additional 10 years of storage capacity, which is expected to be sufficient up to the year 2008 for Unit 1 and 2012 for Unit 2.

The spent fuel storage racks are designed and shall be maintained with:

a. A maximum Keff equivalent of 0.95 with the storage racks filled with unborated water.

b. A nominal 10.5 inch center-to-center distance between fuel assemblies stored in Region I (flux trap type) racks.

c. A nominal 9.05 inch center-to-center distance between fuel assemblies stored in Region II (non-flux trap) racks.

d. Fuel assemblies stored in Region I racks shall meet one of the following limiting conditions.

   1. Unirradiated fuel assemblies with a maximum enrichment of 4.25 w/o U-235 have unrestricted storage.

   2. Unirradiated fuel assemblies with enrichments greater than 4.25 w/o U-235 and less than or equal to 5.0 w/o U-235, that do not contain Integral Fuel Burnable Absorber (IFBA) pins, may only be stored in the peripheral cells facing the concrete wall.

   3. Unirradiated fuel assemblies with enrichments (E) greater than 4.25 w/o U-235 and less than or equal to 5.0 w/o U-235, which contain a minimum number of IFBA pins shall have an equivalent reactivity hold-down which is greater than or equal to the reactivity hold-down associated with N IFBA pins, at a nominal 2.35 mg B-10/linear inch loading (1.5X), determined by the equation below.

$$N = 42.67 (E-4.25)$$

4. Irradiated fuel assemblies with enrichments (E) greater than 4.25 w/o U-235 and less than or equal to 5.0 w/o, that have attained the minimum burnup (BU) as determined by the equation below, have unrestricted storage.

$$BU\ (MWD/kg\ U) = -26.212 + 6.1677E$$

e. Fuel assemblies stored in Region II racks shall meet one of the following limiting conditions.

1. Unirradiated fuel assemblies with a maximum enrichment of 5.0 w/o U-235 may be stored in a checkerboard pattern with intermediate cells containing only water or non-fissile bearing material.

2. Unirradiated fuel assemblies with a maximum enrichment (E) of 5.0 w/o U-235 may be stored in the central cell of any 3x3 array of cells provided the surrounding eight cells are empty or contain fuel assemblies that have attained the minimum burnup (BU) as determined by the equation below.

$$BU\ (MDW/kg\ U) = -15.48 + 17.80E - 0.7038E^2$$

In this configuration, none of the nine cells in any 3x3 array shall be common to cells in any other similar 3x3 array. Along the rack periphery, the non-fueled region is equivalent to 3 outer cells in a 3x3 array.

3. Irradiated fuel assemblies with a maximum enrichment (E) of 5.0 w/o U-235 that have attained the minimum burnup (BU) as determined by the equation below, have unrestricted storage.

$$BU\ (MWD/kg\ U) = -32.06 + 25.21E - 3.723E^2 + 0.3535E^3$$

4. Irradiated fuel assemblies with a maximum enrichment (E) of 5.0 w/o U-235 that have attained the minimum burnup (BU) as determined by the equation below, may be stored in a peripheral cell facing the concrete wall.

$$BU\ (MWD/kg\ U) = -25.56 + 15.14E - 0.602E^2$$

The reactor cavity, refueling canal and spent fuel storage pool are reinforced concrete structures with seam-welded stainless steel plate liners. These Seismic Category I structures are designed to withstand the anticipated earthquake loadings and to prevent gross liner leakage even in the event the reinforced concrete develops cracks.

Design criteria for spent fuel storage racks assure conformance with recognized codes and applicable Regulatory Guides as follows:

1. The spent fuel storage rack design is based on the requirements of the ASME Boiler and Pressure Vessel Code, Section III Subsection NF, Class 3 Linear Supports.

2. Regulatory Guide 1.13 - The design conforms with the Regulatory Guide, except that high radiation instrumentation does not actuate the filtration system for Unit 1.

3. Regulatory Guide 1.29 - The spent fuel storage racks are designed as Seismic Category I Structures.

4. Regulatory Guide 1.92 - Seismic load combinations of vibrational modes and three orthogonal component motions (two horizontal and one vertical) meet the provisions of the Regulatory Guide.

5. Design loads and load combinations meet the requirements of the Standard Review Plan, Section 3.8.4, Structural Design Criteria for Seismic Category I Structures Outside Containment and ASME Section III NF-3400.

6. During the design phase of the reracking in 1994, the following additional documents were used as a reference:

    1. OT Position paper for Review and Acceptance of Spent Fuel Pool Storage and Handling Applications, USNRC, 1978.

    2. USNRC Branch Technical Position ASB9-2, "Residual Decay Energy for Light Water Reactors for Long Term Cooling," Rev. 2, 1981.

9.1.2.2 System Description

A stainless steel lined spent fuel storage pool is provided for onsite storage of spent fuel assemblies until they are transferred to casks for storage at the Independent Spent Fuel Storage Installation (ISFSI) or shipped offsite. Sufficient space is available to hold approximately 8 full core offloads and the depth is sufficient to provide a minimum shielding depth over the top of the stored fuel of 10 feet of water. The pool is designed to prevent inadvertent drainage below a water elevation of 124 feet-8 inches. Storage racks located in the pool are physically arranged such that the assemblies are always maintained in a subcritical condition. Adjacent to the spent fuel pool and separated by a structural wall is the transfer pool. The transfer pool serves to facilitate the fuel transfer operation between the Fuel Handling Building and containment. It is also the pool where the spent fuel transfer or shipping cask is placed for loading/unloading. The cask is handled by the cask handling crane which is prevented by structural restraint from moving over the spent fuel pool.

Rack Modules for Region I (Retained Exxon Racks)

With the implementation of reracking in 1994, three previously installed Exxon racks were retained which are of poisoned flux trap construction to serve as Region I. Each rack module retained in the pool for this purpose consists of one hundred storage cells and has cross-sectional dimensions of 109.5" x 109.5". The locations of the existing modules are shown on Figures 9.1-3 and 9.1-3A.

The high density (poison) spent fuel racks' construction is shown on Figure 9.1-2A. The design utilizes a stiffened module base and an upper box structure consisting of plate diaphragms and a top grid. The storage module is constructed of stainless steel, mostly Type 304. The vertical loads are carried by the module base. Horizontal seismic loads are carried to the module base through the plate diaphragms.

The design of the high density spent fuel storage cells is illustrated on Figure 9.1-3B. Each cell is a square cross-section formed from an inner shroud of stainless steel, a center sheet of aluminum clad boron carbide (B_4C), and an outer shroud of stainless steel. This cell acts as storage space and provides sufficient neutron absorption to allow close spacing of spent fuel. The fuel weight is carried directly on the module base. A flared guide and transition section is provided at the top of each storage cell. This transition is designed to assure ease of entry and to preclude fuel assembly hang-up and damage. Swelling of the inner stainless steel shroud has been observed in a number of the spent fuel storage cells. The swelling is the result of hydrogen gas buildup from the corrosion of the aluminum in the Boral poison plates. The gas buildup has bowed or swollen the cells, thereby reducing the inner cell dimension. An

ongoing program to monitor the condition of the spent fuel storage cells is being conducted. The hydrogen gas will be vented from the swollen cells to allow the shroud to return to some position closer to the original. This may allow the cell to be returned to service as an available spent fuel storage location. The hydrogen gas is radiologically stable and does not present a personnel hazard. The insignificant volume of gas released will not increase the hydrogen concentration in the area into the explosive range.

This condition was reviewed by the NRC in Supplement 4 of NUREG- 0517, Safety Evaluation Report, Salem Generating Station Unit 2, April 1980. It was concluded that the minor degradation of the boral poison plates resulting from the corrosion of the aluminum would not preclude the spent fuel storage cells from performing their intended function.

Rack Modules for Region II (New Holtec Racks)

With the implementation of reracking in 1994, nine existing Exxon racks were replaced with nine maximum density Holtec racks, shown on Figure 9.1-2B. The locations of new rack modules are shown on Figures 9.1-3 and 9.1-3A. These racks have a single poison panel between adjacent austenitic stainless steel surfaces and serve as Region II. The significant components of these racks are: 1) Box cell assembly, 2) Boral panel and Sheathing, 3) Formed and Periphery cells, 4) Baseplate, 5) Support legs.

See Figures 9.1-3C, 9.1-3D, 9.1-3E and 9.1-3F.

1) Box Cell Assembly

The box cells are fabricated from two precision formed channels by continuous seam welding. The inside (nominal) dimension of the box is 8.86 x 8.86 inches. Each box constitutes a storage location. See Figure 9.1-3C.

2) Boral Panel and Sheathing

Boral is used as the neutron absorber material. The boral panels are manufactured by using a homogenized particulate mixture of Boron carbide and aluminum powder sandwiched between thin aluminum sheets using a hot rolling process. The boral panels are placed in the customized flat depression region of the sheathing, which is laid on a side of the "box". The flanges of the sheathing are attached to the box on all four sides using intermittent weld. The sheathing serves to locate and position the boral panel accurately, and to preclude its movement under seismic conditions. See Figures 9.1-3D and 9.1-3E.

3) Formed and Periphery Cells

The boxes with integrally connected sheathing are arranged in a checkerboard array to form the storage cell rack module. This way, formed cells (interior boxes) are automatically created. The inter-box welding and pitch adjustment are accomplished by small longitudinal connectors. Flat plates are welded to the edges of the boxes at the outside boundary of the boxes to create the periphery cells. See Figure 9.1-3C.

4) Baseplate

The baseplate provides a continuous horizontal surface for supporting the fuel assemblies. See Figure 9.1-3F.

5) Support Legs

All support legs are adjustable type. The top portion is made of austenitic stainless steel material. The bottom portion is made of SA564 type 630 age hardened stainless steel to avoid galling problems. See Figure 9.1-3F.

9.1.2.3 <u>Design Evaluation</u>

Borated water is used to fill the spent fuel storage pool at a concentration to match that used in the reactor cavity and refueling canal during refueling operations. The fuel is stored in a vertical array with sufficient center-to-center distance between assemblies to assure $k_{eff} \leq 0.95$ even if unborated water is used to fill the pool. (Based on 17 x 17 fuel with enrichment as described in Section 9.1.2.1).

The spent fuel storage pool is provided with a Spent Fuel Cooling System which is discussed in Section 9.1.3.

The design of the Fuel Handling Building is such that it is physically impossible for a load greater than 5 tons to be carried over the spent fuel pool except during implementation of the rerack project. This is a result of both the physical arrangement of the Fuel Handling Building and limits on the fuel handling crane. Administrative controls prohibit loads greater than that of a fuel assembly to travel over the spent fuel pool. The maximum height at which a fuel assembly can be carried is restricted by limit switches on the crane to 15 inches over the top of the spent fuel racks. The spent fuel racks have been designed to absorb the energy released by a fuel assembly dropping from 15 inches above them for the Exxon racks and 36 inches for the Holtec racks.

During implementation of the re-rack project in 1994, temporary modification was made to the crane, which increased the capacity of the crane from 5 tons to 20 tons. No permanent attachment or welding to the crane was made. This temporary modification was removed at the completion of the project and the crane was brought back to its original capacity of 5 tons.

Special procedures were also implemented to prevent the possibility of a rack under transport from impacting stored fuel. Racks were also temporarily located in the transfer pool (two for Unit 1, one for Unit 2) to reduce the amount of fuel in the Spent Fuel Pool.

The spent fuel storage pool and new fuel storage pit are outside the area over which the fuel cask may travel by design (travel restricted by a limit stop switch). The cask handling crane travels only over the truck bay, decontamination pit and fuel transfer pool, as indicated on Plant Drawing 204836.

Gamma radiation is continuously monitored in the Fuel Handling Building. A high level signal is alarmed locally and is annunciated in the Control Rooms.

All fuel and waste storage facilities are contained and equipment designed so that accidental releases of radioactivity directly to the atmosphere are monitored and will not exceed the limits of 10CFR50.67.

A Controlled Ventilation System removes gaseous radioactivity from the atmosphere in fuel and waste treating areas of the Fuel Handling and Auxiliary Buildings and discharges it to the atmosphere via the plant vent. Radiation monitors are in continuous service in these areas to actuate high-activity alarms in the Control Rooms.

A nuclear criticality accident due to a fuel assembly misloaded in the Spent Fuel Pool has been analyzed. This relates to fuel assemblies loaded in a wrong region as specified in Section 9.1.2.1. One mislocated fuel bundle has been found to be acceptable as long as the soluble boron concentration is maintained above 600 ppm in the Spent Fuel Pool.

A nuclear criticality accident due to the installation of maximum density spent fuel storage racks has been analyzed. Reracked pool design factors that could affect the Spent Fuel Pool neutron multiplication factor have been addressed conservatively. It was concluded that the maximum Spent Fuel Pool neutron multiplication, with the addition of the maximum density racks, will not exceed the subcriticality limit of Keff less than or equal to 0.95 with unborated water.

A rack-to-rack and rack-to-wall impact during a postulated seismic event was analyzed for the spent fuel storage racks for the as-built configuration. The analysis concluded that the rack configuration does not result in rack-to-rack impact in the cellular region for either unit, or rack-to-wall impact for Unit 1 during postulated seismic events. For Unit 2, a rack-to-wall impact is predicted in one location for the DBE case. The calculated value of the impact force is very small and will not cause any damage to the fuel cells, the rack, the wall or pool liner.

9.1.3 Spent Fuel Pool Cooling System

9.1.3.1 Design Bases

The following description is for Unit 1 with Unit 2 having an identical system.

The Spent Fuel Pool Cooling System is designed to remove from the spent fuel pool the heat generated by stored spent fuel elements. The system serves the spent fuel pool which is located in the Fuel Handling Building adjacent to the Containment Building. A secondary function is to clarify and purify spent fuel pool, transfer pool, and refueling water. The system design considers the need to totally unload a reactor at the time when spent fuel is in the fuel pool.

The system design incorporates redundant active components. The system is designed with anti-siphon holes to prevent draining of the spent fuel pool below the top of the stored fuel elements.

The Spent Fuel Pool Cooling System maintains the spent fuel pool at normal temperatures. Boron concentration in the pool fluid is maintained at a minimum of 800 ppm.

9.1.3.2 System Description

The schematic diagram for the Spent Fuel Pool Cooling System is shown on Plant Drawings 205233 and 205333. The Spent Fuel Pool Cooling System

consists of three subsystems: the Cooling System, the Purification System, and the Skimmer System.

Austenitic stainless steel piping is used in the Spent Fuel Pool Cooling System. All piping and components of the system are designed to the applicable codes and standards listed in Table 9.1-1.

The cooling loop consists of the spent fuel pool pumps and the spent fuel pool heat exchanger. The purification loop consists of the spent fuel pool pump, the spent fuel pool filter, the spent fuel pool demineralizer, the refueling water purification pump, and the refueling water purification filter. The skimmer loop consists of the skimmer pump, strainer, and filter.

During the heat removal operation, fuel pool water flows from the spent fuel pool to a spent fuel pool pump suction, and is pumped through the tube side of the heat exchanger, and is returned to the pool. The suction line, which is protected by a strainer, is located at an elevation 4 feet below the pool normal water level, while the return line terminates in the pool at an elevation approximately 6 feet above the top of the fuel assemblies. If the spent fuel pool pump fails, the second pump supplies 100-percent backup.

The Spent Fuel Pool Cooling System has its maximum duty during the refueling operation when the decay heat from the spent fuel is the highest.

Piping and valves are installed which allow the Units 1 and 2 heat exchangers to be cross connected. During normal plant operation, the heat exchangers operate independently to meet the cooling requirements of the individual units. However, if heat load is unusually high, both heat

exchangers may be used in parallel to minimize the temperature rise in the spent fuel pool. The cross connect also allows one heat exchanger to be used to alternatively cool the spent fuel pools in both units during times when one heat exchanger is out for maintenance.

While the heat removal operation is in process, a portion of the spent fuel pool water, 100 gpm, may be diverted through the spent fuel pool demineralizer and spent fuel pool filter to maintain spent fuel pool water clarity and purity. Transfer canal water may also be circulated through the same demineralizer and filter. This is accomplished by having the gate between the transfer pool and the spent fuel pool removed. This purification loop is sufficient for removing fission products and other contaminants which may be introduced if a leaking fuel assembly is transferred to the spent fuel pool.

The demineralizer may be isolated, by manual valves, from the heat removal portion of the Spent Fuel Pool Cooling System. By so doing, it may be used together with the refueling water purification filter to clean and purify the refueling water while spent fuel pool heat removal operations proceed. Connections are provided to the isolated loop such that the refueling water may be pumped from either the refueling water storage tank (RWST) or the refueling cavity, through the demineralizer and filter, and discharged to either the refueling cavity or the RWST.

To further assist in maintaining spent fuel pool water clarity, the water surface is cleaned by a skimmer loop. This system consists of two skimmers, a skimmer pump, a strainer and a filter. Water is removed from the surface by the skimmer, pumped through the strainer and filter, and returned to the pool surface at three locations remote to the skimmers.

Boron may be added to the pool from the Chemical and Volume Control System (CVCS). Borated water from the plant sources may be supplied from the RWST via the refueling water purification pump connection, or by placing a temporary line from the boric acid blender, located in the CVCS directly into the pool. Demineralized water is also added to the pool for makeup purposes by a connection in the recirculation return line.

The pool water may be separated from the water in the transfer pool by a sluice gate. The gate is installed so that the transfer pool may be drained for maintenance on the fuel transfer equipment. The draining is accomplished by pumping transfer pool water into the spent fuel pool with a portable pump. The excess water from the spent fuel pool is directed to a holdup tank in the CVCS or to the decontamination for temporary storage.

With the implementation of reracking in 1994 the spent fuel storage capacity in the pool was increased from 1170 fuel assemblies to 1632 fuel assemblies. The decay heat load calculation was conservatively performed in accordance with the provisions of USNRC Branch Technical Position ASB9-2, "Residual Decay Energy for Light Water Reactors for Long Term Cooling," Rev. 2, July 1981. Three discharge Cases were considered in Cycle 25, 37 years' accumulation of spent fuel:

Case 1) The reactor is shutdown and is cooled for 168 hours. Then, a batch of 88 assemblies with 1642.5 days full power operation is discharged to the pool at a rate of 7 assemblies per hour.

Case 2) Same as case 1 except instead of 88 assemblies, 193 assemblies (Full Core Offload) is discharged.

Case 3) The reactor is back to operation after a refueling shutdown in Cycle 24. Thirty days later, the reactor experiences unplanned shutdown. The full core of 193 assemblies is transferred to the pool 168 hours after the reactor shutdown. Sixty eight assemblies in the core are assumed to have 30 days full power operation and 125 assemblies are assumed to have 1642.5 days full power operation.

The results of the above cases are as follows:

Case 1) 195 hours after the reactor shutdown, the pool will experience a maximum temperature (bulk pool) of 149 degrees F, with one pump and one heat exchanger in operation.

Case 2) 205 hours after the reactor shutdown, the pool will experience a maximum temperature of 180 degrees F, with one pump and one heat exchanger in operation.

Case 3) 204 hours after the reactor shutdown, the pool will experience a maximum temperature of 180 degrees F, with one pump and one heat exchanger in operation.

In 1998, additional spent fuel pool heat removal analyses were performed. The analyses addressed potential full-core off-loads during upcoming refueling outages as well as end of plant life. These analyses concluded one pump and one heat exchanger can maintain pool temperature below 149°F under all combinations of decay time and CCW temperature except minimum decay times and very high cooling water temperatures. Under these later conditions, in vessel decay-time would be extended or parallel heat exchanger operation would be used to maintain pool temperature below 149°F. In addition, provisions have been made for the installation of an additional heat exchanger, should this be required in the future.

Amendments Nos. 289 and 273 for Units 1 and 2, respectively, changed the Technical Specification requirements to allow fuel movement in the containment to commence 80 hours after the reactor has become subcritical between October 15^{th} through May 15^{th}. Supporting analyses demonstrated that Spent Fuel Pool temperature limits will be maintained based on reduced Ultimate Heat Sink temperatures (i.e., below the design value of 90°F) experienced during this time frame and the projected Spent Fuel Pool decay heat load with the pool at full capacity. For the remainder of the year, the decay time limit is 168 hours. A core offload has the potential to occur during both applicable time frames. In order not to exceed the analyzed Spent Fuel Pool cooling capability to maintain the water temperature below 180°F, two decay time limits are provided. In addition, PSEG has developed and implemented a Spent Fuel Pool Integrated Decay Heat Management Program as part of the Salem Outage Risk Assessment. This program requires a pre-outage assessment of the Spent Fuel Pool heat loads and heatup rates to assure available Spent Fuel Pool cooling capability prior to offloading fuel.

Prior to each refueling, the decay heat management program methodology is used to:

- Calculate that the water temperature will not exceed 149°F following full core offload, using only one heat exchanger for each spent fuel pool and to provide to the Operations staff the required component cooling water temperature to achieve such results; and,

- Calculate that the water temperature will not exceed 180°F following full core offload with one heat exchanger available for both spent fuel pools and to provide to the Operations staff the required component cooling water temperature to achieve such results.

Prior to initiating core offload activities, the assumptions used in the Integrated Decay Heat Management Program calculations are validated. The validation includes:

- Ensuring the availability of both spent fuel pool heat exchangers, each with an available spent fuel pit pump, to support spent fuel pool cooling for a full core offload; and,

- Verifying that actual component cooling water supply temperatures are consistent with the decay heat management calculation input values.

Additionally, spent fuel pool high temperature alarm capability is maintained to alert the operators in the event that water temperature exceeds the peak temperature predicted by the decay heat management program for each refueling outage.

Spent Fuel Pool Cooling System component design data are listed in Table 9.1-2. The following is a description of each component utilized in the Spent Fuel Cooling System.

Spent Fuel Pool Heat Exchanger

The spent fuel pool heat exchanger is of the shell and U-tube type with the tubes welded to the tube sheet. Component cooling water circulates through the shell, and spent fuel pool water circulates through the tubes. The tubes are austenitic stainless steel and the shell is carbon steel.

Spent Fuel Pool Pumps

The spent fuel pool pumps circulate water in the Spent Fuel Pool Cooling System. All wetted surfaces of the pumps are austenitic stainless steel, or equivalent corrosion resistant material. The pumps are operated manually from a local station.

Spent Fuel Pool Filter

The spent fuel pool filter removes particulate matter larger than 5 microns from the spent fuel pool water. The filter cartridge is of synthetic fiber and the vessel shell is austenitic stainless steel.

Spent Fuel Pool Strainer

A stainless steel strainer is located at the inlet of the spent fuel pool cooling suction line for removal of relatively large particles which might otherwise clog the spent fuel pool demineralizer.

Spent Fuel Pool Demineralizer

The demineralizer is sized to pass 100 gpm of the loop circulation flow to provide adequate purification of the fuel pool water for unrestricted access to the working area and to maintain optical clarity.

Refueling Water Purification Pump

The refueling water purification pump circulates water in a loop between the RWST and the spent fuel pool demineralizer and the refueling water purification filter. All wetted surfaces of the pump are austenitic stainless steel. The pump is operated manually from a local station.

Refueling Water Purification Filter

The refueling water purification filter removes particulate matter larger than 5 microns from the refueling water purification flow.

Spent Fuel Pool Cooling System Valves

Manual stop valves are used to isolate equipment and lines, and manual throttle valves provide flow control. Valves in contact with spent fuel pool water are austenitic stainless steel or equivalent corrosion-resistant material.

Spent Fuel Pool Cooling System Piping

All piping in contact with spent fuel pool water is austenitic stainless steel. The piping is welded except where flanged connections are used to facilitate maintenance.

Spent Fuel Pool Skimmers

Two spent fuel pool skimmers are provided to remove water from the surface of the spent fuel pool. The skimmer heads are manually

positioned to take water from any elevation from the water surface to 4 inches below the surface. The elevation of the skimmers' head can be manually adjusted over a total range of 2 feet.

Spent Fuel Pool Skimmer Pump

The spent fuel pool skimmer pump circulates surface water through a strainer, a filter, and returns it to the pool.

Spent Fuel Pool Skimmer Strainer

The spent fuel pool skimmer strainer is designed to remove debris from the skimmer process flow.

Spent Fuel Pool Skimmer Filter

The spent fuel pool skimmer filter is designed to remove insoluble particles which are not removed by the strainer.

9.1.3.3 Design Evaluation

The most serious failure of this system would be complete loss of water in the spent fuel pool. To protect against this possibility, the spent fuel pool cooling suction connection enters near the normal water level so that the pool cannot be gravity-drained. The cooling water return lines contain anti-siphon holes to prevent the possibility of gravity draining the pool. For beyond design basis accident mitigation, the tell-tale liner leakoff drain lines have isolation capability to maintain spent fuel pool inventory in the unlikely event that liner failure is anticipated as a result of a complete loss of spent fuel pool cooling. There are no drains or permanently connected systems to the spent fuel pool (Seismic Class I) which, in the event of failure, could cause loss of coolant from the pool that would uncover the fuel. Also, provisions have been made to supply makeup to the spent fuel pool as noted below.

Salem fuel pool cooling systems were designed with substantial reliability. Original design features included a seismic Class II piping stress analysis (upgraded to Class I in 1981), location in seismic Category I buildings, safety-related heat exchangers, a safety-related heat sink (CCW to service water), redundant pumps, and electric power supplied by independent 460 volt 1E buses (backed by emergency diesel generators). Under the original design, the system could be expected to remain functional following any design accident or natural phenomena, except a design basis earthquake (DBE). Since the system components were not seismically qualified, post-DBE functionality was not assured. In that case, if an earthquake caused a sustained loss of forced cooling with recently discharged fuel in the pool, decay heat would have been removed by pool boiling.

As a result of self-assessments performed on the fuel pool and associated structures, systems and components (SSCs) in 1995, concerns were identified that called into question the ability of these SSCs to perform their design basis functions under loss of normal fuel pool cooling conditions as a result of a design basis earthquake where the heat load in the pools could cause the pool temperature to exceed 180°F. These concerns were resolved by a seismic upgrade of the Spent Fuel Pool Cooling System to render temperatures above 180° F non-credible. The upgrade not only evaluated the capability of the system to remain functional following a seismic event, but also evaluated potential single active failures and various external hazards (such as flooding, missiles, seismic-nonseismic interactions, etc.) that could result in interruption of forced cooling. The evaluation concluded pool temperature would be maintained 180°F and below under normal, abnormal, and accident conditions.

The use of the heat-exchanger cross connect is controlled by appropriate procedures. Four manual valves, two per unit, have to be opened to cross connect the heat exchangers. Prior to placing a high heat load in a pool which would require heat exchangers in parallel to minimize the temperature transient, the heat load in the spent fuel pool to be isolated is evaluated to ensure it can tolerate a temporary interruption of cooling. Similarly, before taking one heat exchanger out of service for maintenance, the heat loads in both spent fuel pools are evaluated to verify that the remaining heat exchanger can be used in an alternating fashion to cool both spent fuel pools.

Water loss from the spent fuel pool due to the accidental opening of a sluice gate when the transfer pool is empty will not occur due to the redundancy in the sluice gates. Two sluice gates separate the spent fuel pool from the transfer pool.

A heavy load handling accident would not result in water leakage severe enough to uncover the spent fuel. The maximum load carried over the spent fuel pool is that of a fuel assembly; however, it is not possible to drop a fuel assembly on the spent fuel pool liner plate.

Pool water level indication is provided by individual high and low water level alarms. The alarms are actuated by deviation from normal water level (Elevation 128 feet-8 inches) of plus or minus

6 inches. The alarms are annunciated in the Fuel Handling Building at the spent fuel pool and in the Control Room.

Annunciation of an alarm will be confirmed by visually checking the spent fuel pool water level. Alarms may be expected to occur occasionally due to gradual changes in pool water temperature and surface evaporation. If needed, makeup will be added. Alarms occurring with unusual frequency or for reasons not readily apparent will be further investigated. Frequent inspections will be made of the Fuel Handling Building sump to identify any abnormalities. In addition, a high sump level alarm is provided in the Control Room.

The normal source of makeup water to the spent fuel pool is the Demineralized Water System which distributes water from two 500,000-gallon demineralized water tanks. The tanks and the distribution system do not have seismic classification. Makeup is also available from the primary water storage tank via the primary water makeup pumps (Seismic Class II) and from the CVCS holdup tanks via the holdup tank recirculation pump (Seismic Class II).

Valves have been installed on the existing 6-inch spare nozzles on both RWSTs (364,500 gallons each). These tanks are Class I (seismic). For beyond design basis scenarios, a portable pump, with appropriate suction and discharge connections and hose, has been provided with the capability to deliver approximately 100 gpm makeup water flow from one of the RWSTs directly to the spent fuel pool. The valves installed on the RWSTs will be locked, closed and capped, and will be under administrative control. The portable pump and hose will also be under administrative control to ensure constant and timely availability.

Up to 100 gallons per minute of makeup is also available from the RWST via the refueling water purification loop.

If a leaking fuel assembly is stored in the spent fuel pool, a small quantity of fission products may enter the cooling water. Fission products and other contaminants are removed by the spent fuel pool purification loop.

A failure analyses of system pumps, heat exchangers and valves is presented in Table 9.1-3.

The spent fuel pool water is maintained at normal temperatures except in circumstances as previously described. Boron concentration in the pool fluid is maintained at a minimum of 800 ppm.

9.1.3.4 Tests and Inspections

The active components of the system are in continuous use during normal plant operation and no additional periodic tests are required. Periodic visual inspections and preventive maintenance are conducted following normal industrial practice.

9.1.4 Fuel Handling System

The Fuel Handling System consists of equipment and structures utilized for handling new and spent fuel assemblies in a safe manner during refueling and fuel transfer operations. The Fuel Handling System is shown on Figure 9.1-5.

The design of the Fuel Handling System conforms to the recommendations of Regulatory Guide 1.13.

The Fuel Handling System components are not generally designed to Class I (seismic) requirements because they do not fit within the definition of Class I (seismic) structures. Those components are designed to Class III requirements. The spent fuel racks, spent

fuel pool and spent fuel pool bridge structure, however, are designed to Class I (seismic) requirements. Other components of the Fuel Handling System are not required to operate following a design basis seismic event.

9.1.4.1 System Design and Operation

9.1.4.1.1 System Description

The reactor is refueled with equipment designed to handle the spent fuel under water from the time it leaves the reactor until it is placed in a cask for storage at the Independent Spent Fuel Storage Installation (ISFSI) or shipment from the site. Underwater transfer of spent fuel provides an effective, economic and transparent radiation shield, as well as a reliable cooling medium for removal of decay heat. Boric acid is added to the water to ensure subcritical conditions during refueling.

In the reactor cavity, fuel is removed from the reactor vessel, transferred through the water and placed in the fuel transfer system by a manipulator crane. In the spent fuel pool, fuel is removed from the transfer system and placed in storage racks with a long manual tool suspended from the fuel handling crane.

9.1.4.1.2 Refueling Operation

The refueling operation follows a detailed procedure which provides a safe, efficient refueling operation. The following significant points are assured by the refueling procedure:

1. The refueling water and the reactor coolant will contain sufficient boron concentration such that together with the control rods are sufficient to keep the core approximately 5 percent $\Delta k/k$ subcritical during the refueling operations. (Required Refueling Boron concentration is reported in the COLR).

2. The water level in the refueling canal will be high enough to keep the radiation levels within acceptable limits when the fuel assemblies are being removed from the core. This water also provides adequate cooling for the fuel assemblies during transfer operations.

While one unit is being refueled, there will be no restrictions on the operation of the other unit. Refueling of one unit will not affect the safety aspects of the other unit.

9.1.4.1.3 Refueling Procedure

The following is a summary only of various steps taken for reactor refueling. The sequence and details may differ in actual procedure.

Preparation

1. The reactor is shut down, borated to refueling concentration, and cooled to ambient conditions.

2. A radiation survey is made and the containment is entered.

3. Intentionally Left Blank.

4. Intentionally Left Blank.

5. CRDM cables are disconnected.

6. Reactor vessel flange area head insulation is removed.

7. The canal drain valves are closed and the fuel transfer tube flange is removed.

8. The in-core instrumentation thimble guides are disconnected at the seal table and extracted downward through the bottom of the reactor vessel.

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

10. The reactor vessel head studs are removed to storage.

11. Guide studs are installed and remainder of the stud holes are plugged.

12. The reactor vessel cavity seal is installed.

13. Checkout of the fuel transfer device and manipulator crane is started.

14. Final preparation of underwater lights and tools is made. Checkout of manipulator crane and Fuel Transfer System is completed.

15. The reactor cavity is filled with water to the vessel flange.

16. The reactor vessel Integrated Head Assembly (IHA) is unseated and raised 1 foot with the polar crane.

17. The reactor vessel IHA is taken to the storage pedestal.

18. The reactor cavity is filled with water to refueling level.

19. The control rod drive shafts are unlatched.

20. The reactor vessel internals lifting rig is lowered into position by the polar crane and latched to the support plate.

21. The reactor vessel internals are lifted out of the vessel and placed in the underwater storage rack.

22. The core is now ready for refueling.

Refueling

The refueling sequence is now started with the manipulator crane. The sequence is as follows:

1. Core Shuffle

   A. Spent fuel is removed from the core and placed into the Fuel Transfer System for removal to the spent fuel pool.

   B. Partially spent fuel is transferred from the intermediate region of the core to the vacated positions in the center region.

   C. Partially spent fuel is transferred from the outer region of the core to vacated positions in the intermediate region.

   D. Fuel assemblies are brought in from the spent fuel pool through the Transfer System and loaded into the outer region.

   E. Whenever fuel is added to the reactor core, source range counts are monitored to ensure unexpected count rate increases do not occur.

2. Full Core Offload

   A. All spent fuel and partially spent fuel is systematically unloaded from the core and placed in the Fuel Transfer System for removal to the spent fuel pool.

B. All insert changeouts are then performed in the spent fuel pool using RCCA change fixture BPRA handling tool and thimble plug handling tool.

C. New fuel and partially spent fuel is systematically brought in from the spent fuel pool and reloaded into the reactor core.

D. Whenever fuel is added to the reactor core, source range counts are monitored to ensure unexpected count rate increases do not occur.

THIS PAGE INTENTIONALLY LEFT BLANK

Reactor Reassembly

1. The fuel transfer car is parked and the fuel transfer tube isolation valve closed.

2. The reactor vessel internals' package is picked up by the polar crane and replaced in the vessel. The reactor vessel internals' lifting rig is removed to storage.

3. The full-length control rod drive shafts are relatched to the RCC elements.

4. The manipulator crane is parked.

5. The reactor vessel O-ring grooves are cleaned and new O-rings installed on reactor head.

6. Drain cavity of water.

7. The flange surface is manually cleaned.

8. The reactor vessel IHA is picked up by the polar crane and positioned over the reactor vessel.

9. The reactor vessel IHA is slowly lowered.

10. The reactor vessel IHA is seated.

11. The reactor vessel to cavity seal is vented and removed.

12. Lift head again for final inspection.

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

14. The head studs are installed and retorqued.

15. The canal drain valves are opened and the fuel transfer tube flange is installed.

16. In-core flux thimbles are inserted back into core area.

17. Electrical leads are reconnected to CRDMS.

18. Reactor vessel head insulation is installed.

19. Control rod drives are checked.

20. Intentionally Left Blank.

21. Intentionally Left Blank.

22. Equipment access door is closed and sealed at the end of the refueling process.

9.1.4.1.4 Major Structures Required for Refueling

Reactor Cavity

The reactor cavity is a reinforced concrete structure that forms a pool above the reactor when it is filled with borated water for refueling.

The cavity is filled to a depth that limits the radiation at the surface of the water to 2.5 mR/hr during those brief periods when a fuel assembly is transferred over the reactor vessel flange.

The reactor vessel flange is sealed to the bottom of the reactor cavity by a cavity seal which is installed prior to flooding the cavity for refueling operations.

The cavity is large enough to provide storage space for the reactor upper and lower internals, the control cluster drive shafts, and miscellaneous refueling tools.

The floor and sides of the reactor cavity are lined with stainless steel.

Refueling Canal

The refueling canal is a passageway extending from the reactor cavity to the inside surface of the reactor containment. The canal is formed by two concrete shielding walls which extend upward to the same elevation as the reactor cavity. The floor of the canal is at a lower elevation than the reactor cavity to provide the greater depth required for the fuel transfer upending device and the control cluster changing fixture located in the canal. The transfer tube enters the reactor containment and protrudes through the end of the canal. Canal wall and floor linings are similar to the reactor cavity.

Decontamination Facilities

A decontamination pit located in the fuel handling area has been provided for the decontamination of spent fuel shipping casks prior to their loading on trucks for shipment offsite.

The decontamination pit is also used to prepare the multi-purpose canister (MPC) for dry storage operations at the ISFSI. The HI-TRAC transfer cask containing the MPC is moved from the fuel transfer pool to the decontamination pit after fuel loading. In the decontamination pit, the MPC lid is welded to the canister shell and the MPC fuel cavity is drained, dried, and backfilled with helium. Certain MPC welds are leak tested and the transfer cask/MPC is moved to the truck bay for additional storage preparation activities.

New Fuel Storage Pit

A dry pit with storage racks having a safe geometry is provided in the fuel handling area for storage of approximately one-third of a

core. This pit is located outside of the area over which a spent fuel transfer/shipping cask may travel.

Fuel Transfer Pool

The fuel transfer pool serves to facilitate the fuel transfer operation between the Fuel Handling Building and containment. It is also the pool where the spent fuel transfer and shipping casks are placed for loading.

9.1.4.1.5 Major Equipment Required for Refueling

Reactor Vessel Stud Tensioner

The stud tensioner is a hydraulically operated (oil as the working fluid) device provided to permit preloading and unloading of the reactor vessel closure studs at cold shutdown conditions. Stud tensioners were chosen in order to minimize the time required for the tensioning or unloading operations. Three tensioners are provided and they are applied simultaneously to three studs 120° apart. One hydraulic pumping unit operates the tensioners which are hydraulically connected in parallel. The studs are tensioned to their operational load in two steps to prevent high stresses in the flange region and unequal loadings in the studs. Relief valves are provided on each tensioner to prevent over tensioning of the studs due to excessive pressure. Charts indicating the stud elongation and load for a given oil pressure are included in the tensioner operating instructions. In addition, micrometers are provided to measure the elongation of the studs after tensioning.

Reactor Vessel Head Lifting Rig

The reactor vessel integrated head assembly and lifting devices are shown on Figure 9.1-6A.

The three vertical legs, platform assembly, and sling assembly (tripod) are permanently attached to the three reactor vessel head lifting lugs. The total estimated weight of the Integrated Head Assembly is approximately 191 tons including studs, nuts and washers, or 172.5 tons without studs, nuts and washers.

The maximum drop height of the reactor vessel head is 39 feet.

The Integrated Head Assembly (IHA) Lift Rig is made up of a combination of the existing lift rig eye and a new lift assembly. The existing load cell linkage connects the polar crane hook and the existing lift eye when installing and removing the IHA. With respect to the tripod lifting eye, load bearing members are no stressed beyond one-fifth the ultimate strength when subjected to the static and dynamic load of the IHA. With respect to the remainder of the IHA lift rig assembly, load bearing members are not stressed to greater than one-tenth of the ultimate strength when subjected to the static and dynamic loads of the IHA.

All primary load-bearing members are constructed with material purchased to ASTM Standards. All welding and nondestructive testing of the IHA Lifting Rig (excluding the existing lift eye) is performed in accordance with approved reference [8] and applicable codes. All welding and nondestructive tests of the lift eye and load cell linkage are in accordance with approved Westinghouse Process Specification and ASME Boiler and Pressure Vessel Codes.

The following loading data apply to the IHA lifting rig.

1. The design load rating for the IHA lifting rig is 200 tons.

2. Preoperational load tests for the IHA lifting rig are the actual weight of the assembled IHA and done at the plant site, followed by nondestructive testing of key load bearing areas.

3. The maximum operating load for the IHA lifting rig is 172.5 tons

4. The IHA is permanently attached to the reactor vessel. Therefore, load testing prior to lifting the IHA is impractical.

Missile Shield Structure Lifting Rig

The integrated head assembly missile shield, including the IHA lifting device, is shown in Figures 9.1-7A.

The missile shield structure is a 181-inch diameter, 2-inch thick steel plate that is part of the Integrated Head Assembly.

Reactor Internals Lifting Rig

The internals lifting rig is a three-legged structural frame device which connects the main crane hook to the upper or lower internals package for handling operations. It connects to the internals flanges by means of screw threads. The internals lifting rig is shown on Figure 9.1-9.

The maximum drop height of the core barrel assembly is 69 feet, which is the limit of travel of the polar crane hook with the upper core barrel assembly and lifting rig attached.

Load bearing members of the rig are not stressed to greater than one-fifth of the ultimate strength when subjected to the static weight of the rig and the lower internals package. All primary load bearing members are constructed with materials purchased to ASTM Standards. All welding and nondestructive testing is done in accordance with approved Westinghouse Design Specifications or the ASME Boiler and Pressure Vessel Codes.

The following loading data apply to the reactor internals lifting rig:

1. Preoperational load tests for the internals lifting rig is the actual weight of the lower internals (estimated at 136 tons with lifting rig) followed by nondestructive testing of key load bearing areas.

2. The maximum operating load for the internals lifting rig is approximately 171 tons. The maximum polar crane capacity is 230 tons.

3. The Westinghouse NES operating instructions for the lifting rig include nondestructive testing of key areas prior to lifting as a routine precaution.

Manipulator Crane

The manipulator crane is a rectilinear bridge and trolley crane with a vertical mast extending down into the refueling water. The bridge spans the reactor cavity and runs on rails set into the floor along the edge of the reactor cavity. The bridge and trolley motions are used to position the vertical mast over a fuel assembly in the core.

A long tube with a pneumatic gripper on the end is lowered down from 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, while inside the mast tube, is transported to its new position.

All controls for the manipulator crane are mounted on a console on the trolley. The bridge is positioned on a coordinate system laid out on one rail. The electrical readout system on the console indicates the position of the bridge. With the aid of a scale the trolley is positioned on the bridge structure. The scale is read

directly by the operator at the console. The drives for the bridge, trolley and winch are variable speed, including a separate inching control on the winch. Electrical interlocks and limit switches on the bridge and trolley drives protect the equipment. In an emergency, the bridge, trolley and winch can be operated manually using a handwheel on the motor shaft.

In addition to the travel limit switches on the bridge and trolley drives, the following safety features are incorporated in the system:

1. Bridge, trolley, and winch drives are mutually interlocked to prevent simultaneous operation of any two drives.

2. Bridge and trolley main motor drive operation is prevented except when the GRIPPER TUBE UP position switch is actuated.

3. The engage and disengage solenoid valves in the air line to the gripper are de-energized except when zero suspended weight is indicated by a force gage. A backup protection for this interlock is the mechanical weight actuated lock in the gripper which prevents operation of the gripper under load even if air pressure is applied to the operating cylinder.

4. Hoist drive circuit in the up direction is opened when the GRIPPER IS DISENGAGED or when the EXCESSIVE SUSPENDED WEIGHT switch is actuated by a loading in excess of 110 percent of a fuel assembly weight. Fuel loading procedures require close observance of the load cell readout and stopping crane motion on predetermined load differentials during fuel assembly movement in the core.

5. Hoist drive circuit in either direction is operated only when either the OPEN and CLOSED indicating switch or the gripper is actuated.

6. Bridge and trolley drives are interlocked in the direction of the Transfer System so that the bridge is prevented from traveling beyond the core area unless the trolley is aligned with the refueling canal centerline. The trolley drive is locked out when the bridge is moved beyond the edge of the core.

Suitable restraints are provided between the bridge and trolley structures and their respective rails to prevent derailing due to the Design Basis Earthquake (DBE). The manipulator crane is designed to prevent disengagement of a fuel assembly from the gripper under the DBE.

Fuel Handling Crane

The fuel handling crane is a semi-gantry type crane used to transport new or spent fuel assemblies between their shipping container, storage racks and upending device. Fuel assemblies are handled by means of a special tool suspended from the crane hook. When handling spent fuel, the hook travel and tool length are designed to limit the maximum lift of a fuel assembly to a safe shielding depth.

The fuel handling crane is a separate structure from the spent fuel pool bridge, although they can be coupled together to enable the two to travel as a single unit. The fuel handling crane and its components are designed as Seismic Category 2. The crane components are designed to remain intact during a design basis seismic event.

Fuel Transfer System

The Fuel Transfer System, shown on Figure 9.1-5, is an electrically driven underwater conveyor car that runs on tracks extending from the refueling canal through the transfer tube and into the transfer pool. The conveyor car receives a fuel assembly in the vertical position from the manipulator crane. The fuel assembly is lowered to a horizontal position for passage through the tube, and then is raised to a vertical position in the transfer pool.

During plant operation the conveyor car is stored in the refueling canal. A blind flange is bolted on the transfer tube to seal the reactor containment. A valve seals the transfer tube on the Fuel Building side.

New Fuel Elevator

New fuel is lowered into the transfer pool in the New Fuel Elevator. The carriage (basket) of the New Fuel Elevator is also specially designed to support and position fuel assemblies during fuel repairs, as well as to handle new fuel assemblies during new fuel transfer. When the New Fuel Elevator is used for fuel repairs, elevator hard stops are installed on the rails above the elevator basket to prevent inadvertently raising an irradiated fuel assembly above a safe shielding water depth.

Cask Handling Crane

The cask handling crane is a bridge and trolley crane used to: 1) transfer new fuel containers from the truck bay to the lay down area near the new fuel storage area, 2) move spent fuel shipping casks from the transfer pool to the decontamination pit and to the truck bay, and 3) move spent fuel transfer casks from the transfer pool to the decontamination pit and to the truck bay. The cask handling crane complies with the requirements of ASME NOG-1-2004. Compliance with ASME NOG-1-2004 is an acceptable method for satisfying NUREG 0554 and NUREG 0612, as identified in NRC Standard Review Plan (SRP) 9.1.5 Revision 1.

The trolley frame complies with ASME NOG-1-2004 Sections NOG-4430 and NOG-4343. The trolley wheels comply with NOG-1-2004 Section NOG-5452.

The hoist breaking system includes one power control breaking system and two holding brakes. Energizing the holding breaks releases the main hoist driveline for operation. In the event of a drive fault the holding breaks are immediately set. The hoist holding breaks and emergency breaks are designed in accordance with ASME NOG-1-2004 Section NOG-5414. Mechanical holding breaks automatically activate when electric power is off or mechanically tripped by over speed or overload. The holding break is single failure proof. Each holding break has a torque rating equal to or greater than 125% of full load hoisting torque at the point of application.

The rope drum complies with ASME NOG-1-2004 Section NOG-5411. The drum safety structure will limit motion of the drum following failure. Wire ropes are rated for 115 tons for the main hoist and 10 tones for the auxiliary hoist and comply with NOG-1-2004 Section NOG-5425. A wire rope spooking monitor is provided.

The load block complies with NOG-1-2004 Section NOG-5420 and is submersible. The block shall remain balanced following the failure of one wire rope. The CHC is capable of withstanding tube blocking, load hang up and other severe overloads as defined by NOG-1-2004 Section NOG-6110.

The main and auxiliary hoist and trolley are single failure proof and comply with ASME NOG-1-2004.

The following load data apply to the cask handling crane:

Design Load Rating - Tons (5 to 1 S.F.)	Test Load, Tons	Max. Operating Load, Tons	Live Test Load, Tons
115	144	115	144

NOTE: The cask handling crane can be load tested for a lower capacity using the standards below, and may be used to lift loads lower than those listed above.

The applicable codes and standards for the cask handling crane follow.

Federal

Safety Code for Overhead and Gantry Cranes, USA Standard B 30.2.0 - 1967 (Now ANSI B 30.2.0 - 1967)

New Jersey

New Jersey Administrative Code, Title 12, Chapter 148, Overhead and Gantry Cranes

Other

Electric Overhead Crane Institute Specification No. 61 (Now superseded by Crane Manufacturers Association of America Specification No. 70)

ASME NOG-1-2004, Rules for Construction of Overhead and Gantry Cranes

One or more of these codes and standards covers the design, fabrication, installation, and testing of the cranes. The hooks, cables, hoists, trolleys, and bridges are tested after erection to a minimum of 125 percent of their design load rating and thereby testing the supporting structure and rails.

Polar Gantry Crane (Containment Crane)

The polar gantry crane was fabricated by Whiting Corporation. Earthquake analysis was performed by using the Jet Propulsion Laboratory Structural Analysis Computer Program No. SL-S780 as modified by the Illinois Institute of Technology Research Institute. Floor response spectrum at the crane rail level was supplied by Conrad Associates. A critical damping factor of 1 percent was used. The maximum stresses induced from the DBE do not exceed 90 percent of the yield strength of the materials used in each gantry crane member.

Rail lugs and stops, which are used to prevent the gantry from overturning or rolling during earthquake motion, are designed to withstand the vertical and horizontal earthquake excitations simultaneously as well as overturning or rolling. Heavy anchor bolts, rail clamps and rail lugs are provided to withstand the uplift force and prevent the crane from being dislodged.

In terms of detailed description the polar crane is the same as the cask handling crane with the following exceptions:

1. 16 parts of cable support the block

2. The two independent braking systems are both electric and described with the addition of eddy-current brakes for control braking

3. Class 162 resistors

The codes and standards identified for the cask handling crane also apply to the polar crane.

The following load data apply to the polar crane:

Design Load Rating - Tons (5 to 1 S.F.)	Test Load, Tons	Max. Operating Load, Tons	Live Test Load, Tons
230 (460)*	500	230 (460)*	288

*Special reeving required for 460 tons.

The design of gearing, shafting, cables, and keys is based on the loads that are applied to each particular part with a factor of safety of at least 5, based on the average ultimate strength of the materials. There are two independent braking systems, each capable of stopping and holding the rated load at any position.

Administrative controls shall be in effect during handling of objects over an opened reactor vessel.

Rod Cluster Control Changing Fixture

Rod cluster control elements are transferred from one fuel assembly to another by means of the RCC changing fixture. Five major subassemblies comprise the changing fixture including: (1) frame and track structure, (2) carriage, (3) guide tube, (4) gripper, and (5) drive mechanism. The carriage is a movable container supported by the frame and track structure. The tracks provide a guide for the four flanged carriage wheels and allow horizontal movement of the carriage during changing operations. Positioning stops on both the carriage and frame locate each of the three carriage compartments directly below the guide tube. Two of these compartments are designed to hold individual fuel assemblies while the third is made to support a single RCC

element. Situated above the carriage and mounted on the refueling canal wall is the guide tube. This assembly provides for the guidance and proper orientation of the gripper and RCC element as they are being raised or lowered. The gripper is a pneumatically actuated mechanism responsible for engaging the RCC element. It has two flexure fingers which can be inserted into the top of the RCC element when air pressure is applied to the gripper piston. Normally the fingers are locked in a radially extended position. Mounted on the operating deck is the drive mechanism assembly. Its components include: 1) manual carriage drive mechanism, 2) revolving stop operating handle, 3) pneumatic selector valve for actuating the gripper piston, and 4) electric hoist for elevation control of the gripper. The RCC change fixture is located in the containment and, since it is not in the proximity of the spent fuel pool, there is no likelihood of its dropping or falling and damaging stored fuel.

Spent Fuel Shipping Cask

The multi-purpose canister (MPC) used for dry spent fuel storage at the ISFSI is dual-purpose certified for storage in a concrete HI-STORM overpack under 10CFR72 (Certificate of Compliance (CoC) 1014) and for transportation in a sealed metal HI-STAR overpack under 10CFR71 (CoC 9261). It is expected that the sealed MPCs will be transferred directly from ISFSI storage into the HI-STAR overpack for shipping without having to move the MPC back to the spent fuel pool to repackage the fuel. However, the option for PSEG to move spent fuel in the spent fuel pool directly into a shipping cask in the fuel transfer pool is being retained. The specific shipping cask that would be used if this option is pursued has not been selected.

Spent Fuel Transfer Cask

Dry storage of spent fuel at the ISFSI involves the use of the HI-TRAC transfer cask inside the Fuel Handling Building. The HI-TRAC transfer cask is lifted and handled only with a single-failure-proof lifting system, as defined in NUREG-0612, Section 5.1.6. The lifting system includes the cask handling crane (CHC) and a lift yoke. There are no lift height limits for the transfer cask when lifted by the CHC lifting system.

Lift Yoke

A specially designed lift yoke is used to lift and handle the HI-TRAC transfer cask inside the Fuel Handling Building with the CHC.

The lift yoke is considered a special lifting device as defined in NUREG-0612, Section 5.1.6, and is part of the CHC single-failure-proof lifting system. The lift yoke is designed to engage the CHC hook at its top and engage the two HI-TRAC transfer cask lifting trunnions via lift links extending from the bottom of the yoke. The lift yoke is also used to transfer the loaded MPC between the HI-TRAC transfer cask and the HI-STORM overpack in the Fuel Handling Building truck bay. In this configuration, slings, meeting the guidance in NUREG-0612, Section 5.1.6, for single-failure-proof lift devices, are connected between the lift yoke and lift brackets on the MPC to raise or lower the MPC. The MPC lift brackets are designed as single-failure-proof lifting devices per NUREG-0612.

9.1.4.2 Design Evaluation

Gamma radiation levels in the containment and fuel storage areas are continuously monitored. These monitors provide an audible alarm at the initiating detector indicating an unsafe condition. During reactor vessel head removal and while loading and unloading fuel from the reactor, the boron concentration is maintained at the most restrictive of the following reactivity conditions:

a) A K-effective (k_{eff}) of 0.95 or less at All Rods In (ARI), Cold Zero Power (CZP) conditions with a 1% $\Delta k/k$ uncertainty added.

b) A k_{eff} of 0.99 or less at All Rods Out (ARO), CZP conditions with a 1% $\Delta k/k$ uncertainty added.

c) A boron concentration of greater than or equal to 2000 ppm, which includes a 50 ppm conservative allowance for uncertainties.

Adequate shielding for radiation is provided during reactor refueling by conducting all spent fuel transfer and storage operations under water. This permits visual control of the operation at all times while maintaining low radiation levels, less than 2.5 mR/hr for periodic occupancy of the area by operating personnel. Pool water level is monitored, and water removed from the pool must be pumped out since there are no gravity drains.

Direct communication between the Control Room and the refueling cavity manipulator crane is available whenever changes in core geometry are taking place.

This provision allows the Control Room operator to inform the manipulator operator of any impending unsafe condition detected from the main control board indicators during fuel movement.

Detailed instructions are available for use by refueling personnel. These instructions, safety limits and conditions and the design of the fuel handling equipment incorporating built-in interlocks and safety features, provide assurance that no incidents occur during the refueling operations that result in a hazard to public health and safety.

When core geometry is being changed, core subcritical neutron flux is continuously monitored by at least two neutron monitors, each with continuous visual indication and one with audible indication in the containment. When core geometry is not being changed, at least one neutron flux monitor is in service. This permits maintenance of the instrumentation. Normally a "high flux at shutdown" condition will cause the containment evacuation horn to sound. During shutdown, and while welding is in progress inside containment, automatic sounding of the containment evacuation horn is defeated. Instead, the control room operator evaluates high flux at shutdown alarms. If produced by welding (a spike is seen on the source range recorders) no action is taken. If no spike is seen, the operator will assume that high radiation exists and will manually sound the containment evacuation horn.

At least one residual heat removal pump is operable. The residual heat removal pump is used to maintain a uniform boron concentration. When changes in core geometry are taking place, one charging pump capable of injecting borated water to the reactor coolant is available at all times.

When the ECCS or Containment Spray System is specified to be operable, the RWST contains not less than the minimum required to permit circulation after the loss-of-coolant accident (LOCA) and has a boron concentration of not less than refueling concentration requirements.

The RWST capacity is 400,000 gallons. For the initial fuel loading, a shutdown k_{eff} of 0.90 or less is required. This is obtained by using refueling water with a boron concentration of 2000 ppm.

The core design process for the first and all subsequent cores ensures that cold shutdown and refueling conditions always can be achieved and maintained. Analysis of LOCA incidents shows that the quantity of water in storage is sufficient for limiting core temperatures and containment pressure following any incident.

9.1.4.3 Analysis of Load-Drop Accidents

The physical limitations on maximum drop height are set by the limit of travel of the polar crane hook; however, no components are lifted to a height greater than that necessary for maneuverability during handling operations. The total analyzed IHA drop weight is 369.9 Kips. In addition to that head weight, the drop height considered is 39 ft., which is the actual height to clear the lift rig for the internals. The most severe and bounding case is the case of the inclined drop, with impact above the supported hot leg nozzle. For that case, the calculated ductility demand is 18.7, which is acceptable as it is smaller than the maximum allowable value of 20.0 [6].

No reduction in dynamic load was taken due to the damping effect of the head falling through 26 feet of water.

It is very unlikely that the dropping of the reactor vessel head would disrupt the flow of coolant to and from the reactor vessel and refueling canal.

Some local yielding of the nozzles (supports) may occur which could cause relative displacement between the vessel seal ledge and concrete seal support ring which could cause seal failure. However, loss of refueling water above the seal has no safety significance, since no fuel handling is in progress during reactor vessel head handling operations.

During the postulated drop of the reactor vessel head or upper core barrel assembly to the reactor vessel, some fuel rods may fail with subsequent release of the fission gases. The radiation monitoring system, however, will detect the released radioactive gas and immediately isolate the reactor containment.

No heavy loads are handled over equipment required for the safe shutdown of the plant during the movement of fuel from the reactor cavity to the spent fuel pool or vice versa, or the movement of a cask. The handling of fuel is all within the reactor cavity, fuel transfer canal and spent fuel pool. The cask is moved within certain areas of the Fuel Handling Building. No equipment required for safe shutdown is located in any of these areas.

The physical arrangement of the Fuel Handling Building is such that the transfer pool is separated from the spent fuel pool. The cask can travel only over the transfer pool and is only lifted with the single-failure-proof cask handling crane lifting system. For this reason, no analysis of cask drop in the transfer pool was required, nor was any performed.

9.1.4.4 Tests and Inspections

Prior to initial fueling, preoperational checkouts of the fuel handling equipment were performed to ensure proper performance of the fuel handling equipment and to familiarize plant operating personnel with operation of the equipment.

Prior to subsequent refueling operations, the equipment is inspected for operability and certain components, such as the fuel transfer car and manipulator crane, are operated to ensure reliable performance prior to moving irradiated fuel.

9.1.4.5 Dry Spent Fuel Storage

After a sufficient time of storage in the spent fuel pool, spent fuel may be moved into dry storage at the on-site Independent Spent Fuel Storage Installation (ISFSI). The ISFSI is located north of Hope Creek Generating Station and is licensed to store spent fuel from both Salem and Hope Creek. The ISFSI is operated under the general license provision of 10CFR72, Subpart K, which requires the use of an NRC-certified spent fuel storage cask. PSEG uses the HI-STORM 100 System for dry spent fuel storage, listed under Certificate of Compliance (CoC) 1014 in 10CFR72.214. The CoC holder licenses the dry storage cask system generically. For additional details on the generic design and operation of the spent fuel storage casks and the ISFSI, refer to the HI-STORM 100 CoC, Ref. 10 and Final Safety Analysis Report, Ref. 11. PSEG's use of the generic HI-STORM 100 cask design to store Salem spent fuel at the on-site ISFSI is described in the PSEG 10CFR72.212 Evaluation Report, available in DCRMS.

9.1.5 Control of Heavy Loads

A list of overhead handling systems from which heavy loads can be dropped, resulting in damage to safety-related equipment, is given in Table 9.1-4. Compliance of these systems with the requirements of NUREG-0612, "Control of Heavy Loads at Nuclear Power Plants," are evaluated in detail in References 1 and 2. These evaluations considered the following factors:

1. Load paths and the location of safety-related components.

2. Measures to ensure heavy load are moved within safe pathways.

3. Written procedures for heavy load handling.

4. Procedures for inspection, testing, maintenance and (crane) operator training.

5. Verification of crane design against the guidelines of industry standards such as CMAA-70 (3) and ANSI B30.2-76 (4).

As a result of the initial study (1), lifting devices are being more clearly marked to indicate lift capacity and to distinguish monorail lifting and non-lifting devices. As a result of the follow-up study (2) Public Service Electric & Gas considers the entire program on the evaluation of heavy loads to be complete.

The RV Head drop analysis was redone [6] due to the replacement of the Original Reactor Vessel Closure Head.

9.1.6 References for Section 9.1

1. Quadrex Corporation, "Six-Month Response for Control of Heavy Loads 2, Salem Nuclear Station," December 17, 1981.

2. VTD 315130 Sheet 2, Quadrex Corporation, "Nine-Month Response for Control of Heavy Loads, Salem Nuclear Station Units 1 and 2," February 11, 1985.

3. Crane Manufacturer's Association of America, "Specification for Electric Overhead Traveling Cranes," CMAA-70, 1970.

4. American National Standards Institute, "American National Standard for Overhead and Gantry Cranes," ANSI B30.2.0, 1976.

5. Bradfute, J.L., et. al., "Criticality Analysis of the Salem Units 1 and 2 Fresh Fuel Racks," NFU-VTD-WW-94-08 00, January 1994.

6. VTD 326664, Salem Units 1 & 2 RV Head Drop Evaluation.

7. VTD 317525, Evaluation Of Overhead Handling Systems and Load Drop Consequences for Salem Nuclear Station Units 1 & 2.

8. VTD 326623, AREVA design Specification for an Integrated Head Assembly for Salem Unit 2 and Unit 1.

9. American Society of Mechanical Engineers, "Rules for Construction of Overhead and Gantry Cranes," ASME NOG-1-2004.

10. VTD 400004, Certificate of Compliance for Spent Fuel Storage Casks.

11. VTD 400006, Holtec International Final Safety Analysis Report for the HI-STORM 100 Cask System.

TABLE 9.1-1

SPENT FUEL POOL COOLING SYSTEM CODE REQUIREMENTS

Spent fuel pool heat exchanger, Tube Side	ASME III, Class C
Shell Side	ASME VIII
Spent fuel pool filter	ASME III, Class C
Spent fuel pool demineralizer	ASME III, Class C
Refueling water purification filter	ASME III, Class C
Spent fuel pool piping	ANSI B31.1.0* ANSI B31.7**
Spent fuel pool cooling pump	ASME III, Class C
Spent fuel pool valves	ASA B16.5 or MSS-SP-66

* Used for design

** For piping not supplied by the NSSS supplier, material inspection, fabrication and quality control conform to ANSI B31.7. Where not possible to comply with ANSI B31.7, the requirements of ASME III-1971, which incorporated ANSI B31.7, were adhered to.

TABLE 9.1-2

SPENT FUEL POOL COOLING SYSTEM COMPONENT DESIGN DATA

Spent fuel pool heat exchanger		
Number		1
Design heat transfer, Btu/hr		11.94×10^6
	Shell	Tube
Design pressure, psig	150	150
Design temperature, °F	200	200
Design flow rate, lb/hr	1.49×10^6	1.25×10^6
Design inlet temperature, °F	99	124
Design outlet temperature, °F	107	113.5
Fluid	Component cooling water	Spent fuel pool water (borated demineralized water)
Material	Carbon Steel	Stainless steel
Spent fuel pool pump		
Number		2
Design pressure, psig		150
Design temperature, °F		200
Design flow rate, gpm		2500
Minimum developed head, ft		125
Temperature of pumped fluid, °F		80 - 180
Fluid		Spent fuel pool water (borated demin. water)
NPSH, ft		15
Material		Austenitic Stainless Steel
Spent fuel pool skimmer pump		
Number		1
Design pressure, psig		50
Design temperature, °F		200
Design flow rate, gpm		100
Minimum developed head, ft		50
Temperature of pumped fluid, °F		75 - 180
Fluid		Spent fuel pool water
NPSH, ft		15
Material		Austenitic Stainless Steel

Refueling water purification pump	
Number	1
Design pressure, psig	150
Design temperature, °F	200
Design flow, gpm	100
Minimum developed head, ft	200
Temperature of pumped fluid, °F	40 - 140
Fluid	Borated reactor coolant
NPSH, ft	15
Material	Austenitic Stainless Steel
Spent fuel pool demineralizer	
Number	1
Type	Flushable
Vessel design pressure, psig Internal - psig	200
External - psig	15
Vessel design temperature, °F	250
Design flow rate, gpm maximum	100
Normal flow, gpm	100
Normal operating temperature, °F	120
Normal operating pressure, psig	Approximately 50
Resin type	Approved nuclear grade
Spent fuel pool filter	
Number	1
Type	Replaceable Assembly
Internal design pressure, psig	200
Design temperature, °F	250
Rated flow, gpm	Nom. 100, Max. 150
Filtration requirement	98 percent retention of particles above 5 micron
Spent fuel pool skimmer filter	
Number	1
Type	Replaceable Assembly
Internal design pressure, psig	200
Design temperature, °F	250
Rated flow, gpm	150
Filtration requirement	98 percent retention of particles above 5 micron

TABLE 9.1-2 (Cont)

Refueling water purification filter	
Number	1
Type	Replaceable Assembly
Internal design pressure, psig	200
Design temperature, °F	250
Rated flow, gpm	150
Filtration requirement	98 percent retention of particles above 5 micron
Spent fuel pool strainer	
Number	1
Design flow, gpm	2300
Fluid	Borated demineralized water
Spent fuel pool skimmer strainer	
Number	1
Type	Basket
Rated flow, gpm	100
Design pressure, psig	50
Design temperature, °F	200
Spent fuel pool skimmers	
Number	2
Flow per unit, gpm	50
Manual adjustment, ft	2

TABLE 9.1-3

SPENT FUEL POOL COOLING SYSTEM MALFUNCTION ANALYSIS

	Component	Malfunction	Comments and Consequences
1.	Spent fuel pool pump	Rupture of a pump casing	The casing and shell are designed for 150 psi and 200°F which exceeds maximum operating conditions. The pump is inspectable and is located in the auxiliary building protected against credible accidents. Rupture is not considered credible. (Also see no. 2 below).
2.	Spent fuel pool pump	Pump stops running and cannot be restarted	The remaining full capacity pump can be brought into operation.
3.	Spent fuel pool pump	Manual valve on pump suction or discharge is closed	This is prevented by prestartup and operational checks.
4.	Spent fuel pool pump	Suction strainer plugs	Strainer is cleaned and flow restored.
5.	Spent fuel pool heat exchanger	Tube or shell rupture	Rupture is considered incredible because of low operating pressure.
6.	Spent fuel pool skimmer pump	Pump stops running and cannot be restarted	Spent fuel assemblies continue to be cooled by spent fuel pool pump. Pool water may become slightly murky possibly decreasing visual observations until pump is restored to service. Fuel pool water is clarified to some extent by bypassing spent fuel pool water through spent fuel pool demineralizer.

TABLE 9.1-4

OVERHEAD HANDLING SYSTEMS

OVERHEAD HANDLING SYSTEMS			HEAVY LOAD			
Description	Rated Capacity (ton)	Location (ft)	Description	Weight (lb)	Drop Height (ft)	Safety Related Equipment/ Components Involved in Dropped Lift
Polar Gantry Cranes with Equipment Hatch Jib	230 Main (each) 35 Aux (each)	Containment Building Elevation 130	Upper Internals w/Lifting Rig & Load Block	161,000	30	Reactor Vessel, Primary System Piping, Fuel in Reactor Vessel, RHR piping, RCP, etc.
		Containment Building Elevation 130	Lower Internals w/Lifting Rig & Load Block	339,500	N/A	
		Containment Building Elevation 130	Reactor Vessel Head / IHA	369,900	39	
		Containment Building Elevation 130	Stud Rack with 9 RPV Head studs	7,000	60	
		Containment Building Elevation 130	Removable Walkway and Stairway	4,000	60	

OVERHEAD HANDLING SYSTEMS			HEAVY LOAD			
Description	Rated Capacity (ton)	Location (ft)	Description	Weight (lb)	Drop Height (ft)	Safety Related Equipment/ Components Involved in Dropped Lift
		Containment Building Elevation 130	RCP Motor Access Plugs	30,000	60	
		Containment Building Elevation 130	RCP Motor	77,000	60	
		Containment Building Elevation 130	RCP Motor Flywheel	14,250	60	
Polar Crane Jib		Containment Building Elevation 130	Equipment Hatch	23,300	N/A	
Mobile Cherry Pickers (2)	12.5 15	Containment Building Elevation 130	Stud Rack with 9 RPV Head Studs	7,000	N/A	
Demineralizer & Ion Exchanger Service Monorail	6	Auxiliary Building Elevation 122	Lead Filled Plugs	10,000	22 above El. 102’ 1½ above El. 122’	CVC system control cables running in Trays 1A418, 1A420,2A418, 2A420, Drawing 205841.
			Concrete Floor Plugs	5,000	2	

TABLE 9.1-4 (Cont)

OVERHEAD HANDLING SYSTEMS			HEAVY LOAD			
Description	Rated Capacity (ton)	Location (ft)	Description	Weight (lb)	Drop Height (ft)	Safety Related Equipment/ Components Involved in Dropped Lift
Filter Handling Systems						
1. Spent Fuel Pit Filter Handling Monorail	4	Auxiliary Building	Filter & Filter Bell Elevation 100	3,500	7	Component Cooling water heat exchanger & associated piping, some nearby safety-related cables (not directly below the dropped lift).
2. Reactor Coolant Ion Exchanger & Filter Underhung Bridge Crane	4	Auxiliary	Filter & Filter Bell	3,500	12	1B & 2B motor control center & associated cable trays, filters inside the bell.
3. Refueling Water Purification & Concentrate Filter Monorails	4	Auxiliary Building	Filter & Filter Bell Elevation 100	3,500	7	Possible load swing into liquid waste. Component cooling heat exchanger and piping on the elevation below.
4. Seal Water Injection & Return Filter Monorails	4	Auxiliary Building	Filter & Filter Bell Elevation 84	3,500	9 1/3	Waste gas compressor package, cable trays on the elevation below.
Solid Radwaste Overhead Crane	20	Auxiliary Building Elevation 100	Large Casks	25,000 max	14 Area B ½ Area A	Numerous pieces of safe shut down equipment at Elevation 84', such as containment spray pumps 12 & 22, charging pump 23, associated piping and electric cables. See Note 4.

TABLE 9.1-4 (Cont)

OVERHEAD HANDLING SYSTEMS			HEAVY LOAD			
Description	Rated Capacity (ton)	Location (ft)	Description	Weight (lb)	Drop Height (ft)	Safety Related Equipment/ Components Involved in Dropped Lift
			Hittman Casks Lid	9,500	2½ Area A	
			Portable Demin	9,000	14 Area B	
Auxiliary Feedwater Pumps Monorails	1.65	Auxiliary Building Elevation 84	Motor Driven Pump	4,400	3	Redundant air supply
			Turbine Driven Pump	3,300	3	
Charging Pump Monorails	2.45	Auxiliary Building Elevation 84	Upper Centr. Charging Pump Casing	4,900	3 1/2	Associated CVC piping and waste decon. tanks on the elevation below.
			Recip. Charging Pump Motor	1,500	3 1/2	
			Recip. Charging Pump Coupling	6,000	5	
Component Cooling Pump Monorails	1.6	Auxiliary Building Elevation 84	Component Cooling Pump Motor	2,650	8	There may be occasion to lift over operable component cooling pump in the case of pumps 12 & 13. Waste holdup tanks, monitor tanks, vital cable trays, and service water piping on elevation below.
Safety Injection Pump Monorails	1.3	Auxiliary Building Elevation 84	Safety Injection Pump Motor	2,450	4	Safety injection pump & piping.

OVERHEAD HANDLING SYSTEMS			HEAVY LOAD			
Description	Rated Capacity (ton)	Location (ft)	Description	Weight (lb)	Drop Height (ft)	Safety Related Equipment/ Components Involved in Dropped Lift
Containment Spray Pump Monorails	2.15	Auxiliary Building Elevation 84	Containment Spray Pump Motor	4,000	3 1/4	Associated containment spray piping. Chemical Volume Control (CVC) System and service water piping and vital cable trays on the elevation below.
Monorail Serving Elevation 55' and Elevation 45'	2.15	Auxiliary Elevation 55	Residual Heat Building Motor	3,950 Removal Pump	2 1/2 above el. 55’	Residual heat removal pump and piping.
			Access Plug	12,400	1 above El. 55’	
Temporary Crane	18*	Roof	Misc.			Safety related equipment on the
Mobile Crane	30**	Auxiliary Building el. 140’				floors below.
Cask Handling Overhead Crane	115 Main 10 Aux	Fuel Handling Building Elevation 130	Spent Fuel Cask w/Spent Fuel	200,000		See Notes 1 & 2 Spent fuel in racks Transfer Pool liner
			Bottom Block	4,200		
Service Water Strainers Monorails	5	Service Water Intake Structure above Service Water Strainer El. 90’	Service Water Strainer	7,000	12	Service water piping and header. Intake bays pump suctions on elevation below.
Mobile Crane Crawler Crane	160 275	Service Water Intake Structure El. 112’	Service Water Concrete Cover Plugs (hatch MKPC-1 and MKPC-2)	12,000 & 13,500	1 Area A	Service Water intake structure Service Water piping and header & intake bay pump suctions on the elevation below see Note 4.

Note 1: Because the crane is single failure proof as per ASME NOG-1-2004, a load drop is not credible.

Note 2: The cask handling overhead crane can be load tested for a lower capacity and used to lift lower loads.

Note 3: Deleted.

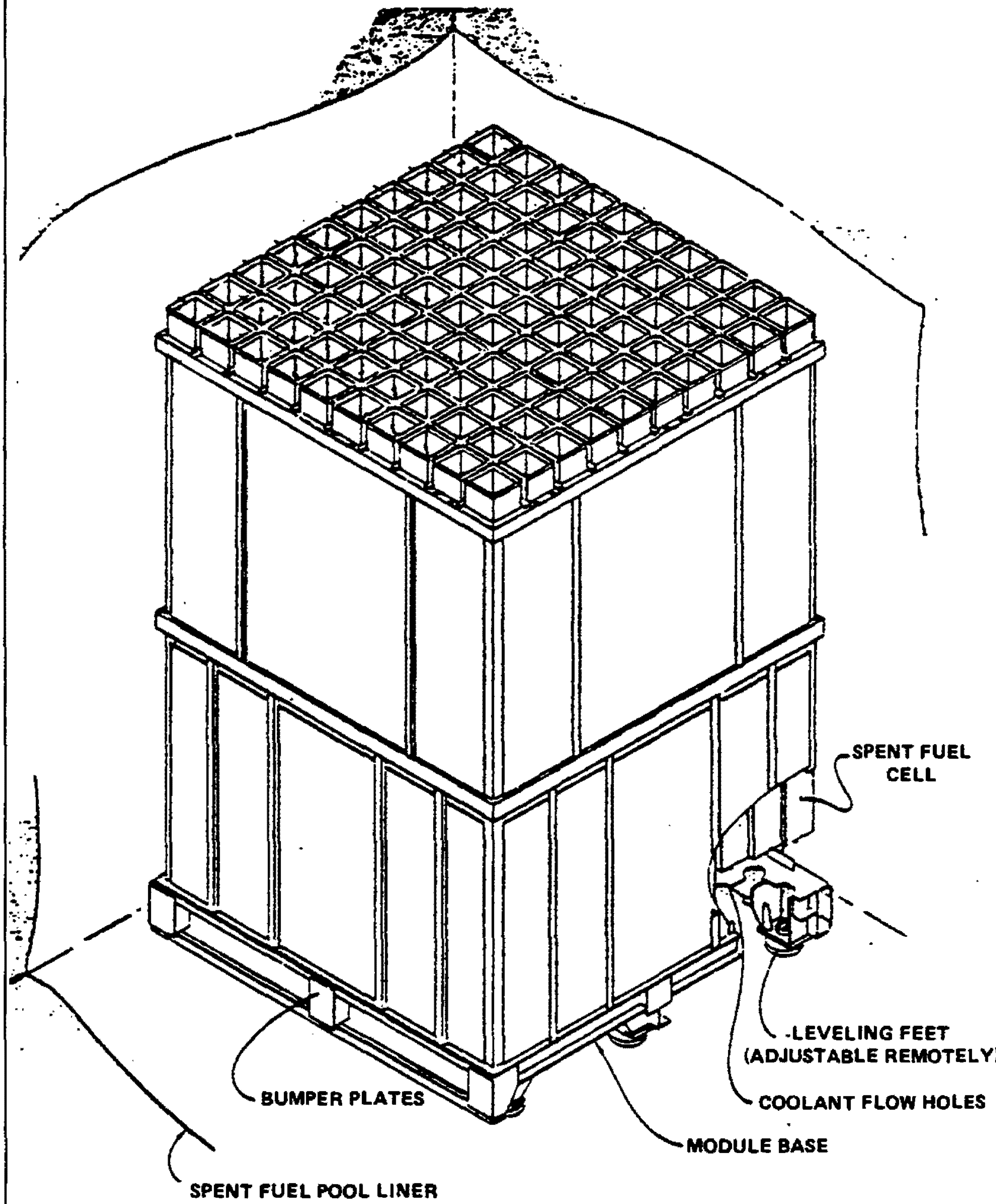
* Original crane is 18 ton Grove crane.
** Tadano crane

OVERHEAD HANDLING SYSTEMS			HEAVY LOAD			
Description	Rated Capacity (ton)	Location (ft)	Description	Weight (lb)	Drop Height (ft)	Safety Related Equipment/ Components Involved in Dropped Lift
			Service Water Pump	12,800		
			Service Water Pump Motor	13,200		
Crawler Crane	275	Service Water Intake Structure El. 112 & 122	Traveling Screens	17,325	12	
			Fish Gate	3,000	12 Area A&B 2 Area C	Service Water intake structure - service water piping and header & intake bay pump sections on the elevation below, see Note 4.

Note 4: For Area locations see VTD 315130 Sheet 2 "Nine-Month Response for Control of Heavy Loads for Salem Nuclear Station Units 1 & 2" figure B-10, A20 and A21.

Figure F9.1-1 intentionally deleted.

Refer to plant drawing 204836 in DCRMS

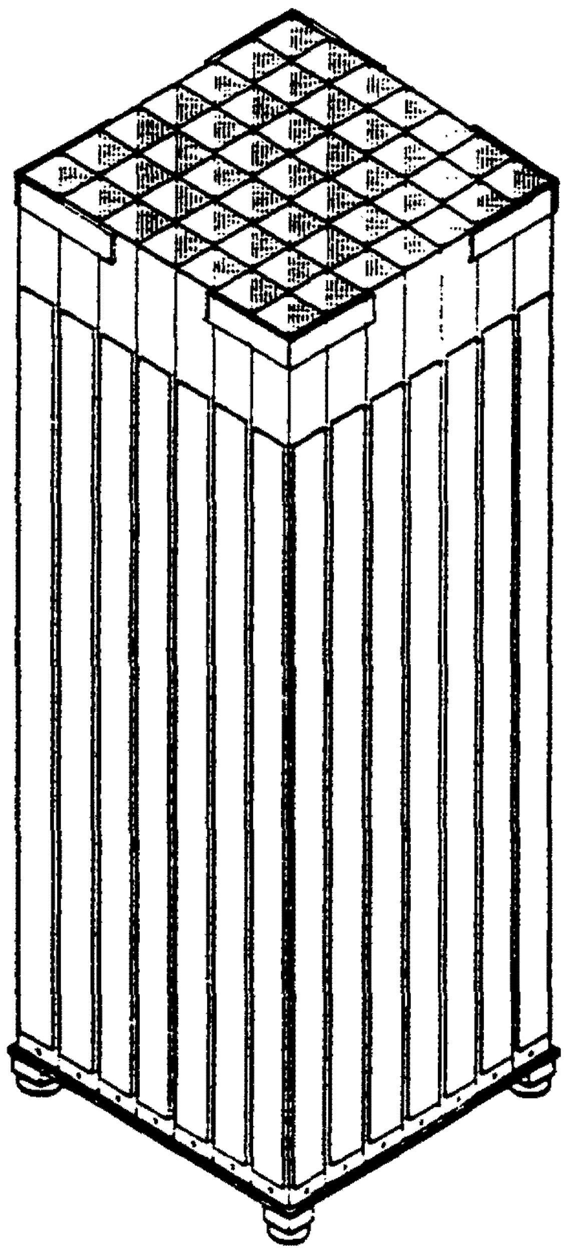


PUBLIC SERVICE ELECTRIC AND GAS COMPANY
SALEM NUCLEAR GENERATING STATION

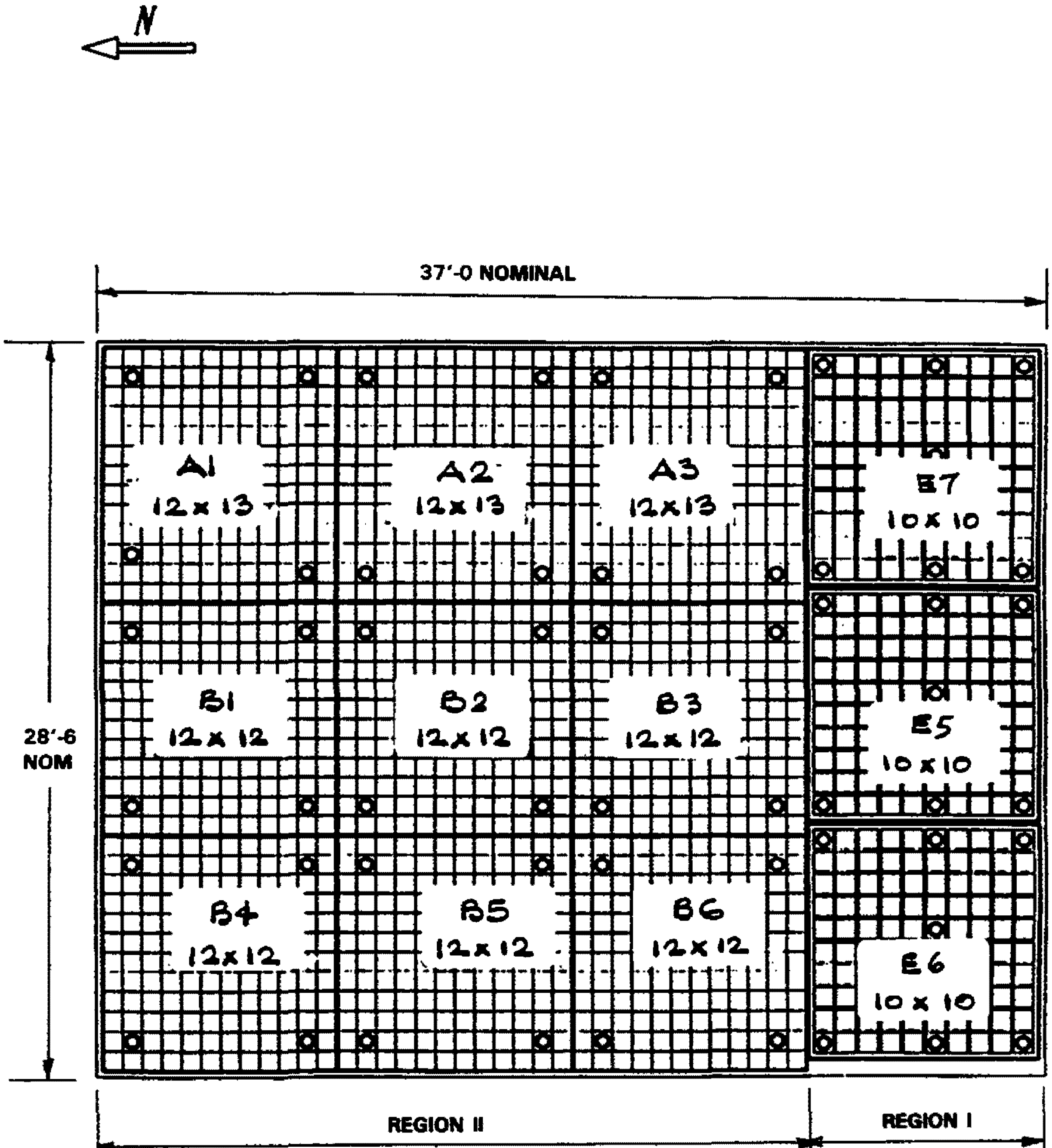
High Density Region I
Spent Fuel Storage Module

Updated FSAR
Revision 15 June 12, 1996

Figure 9.1-2A

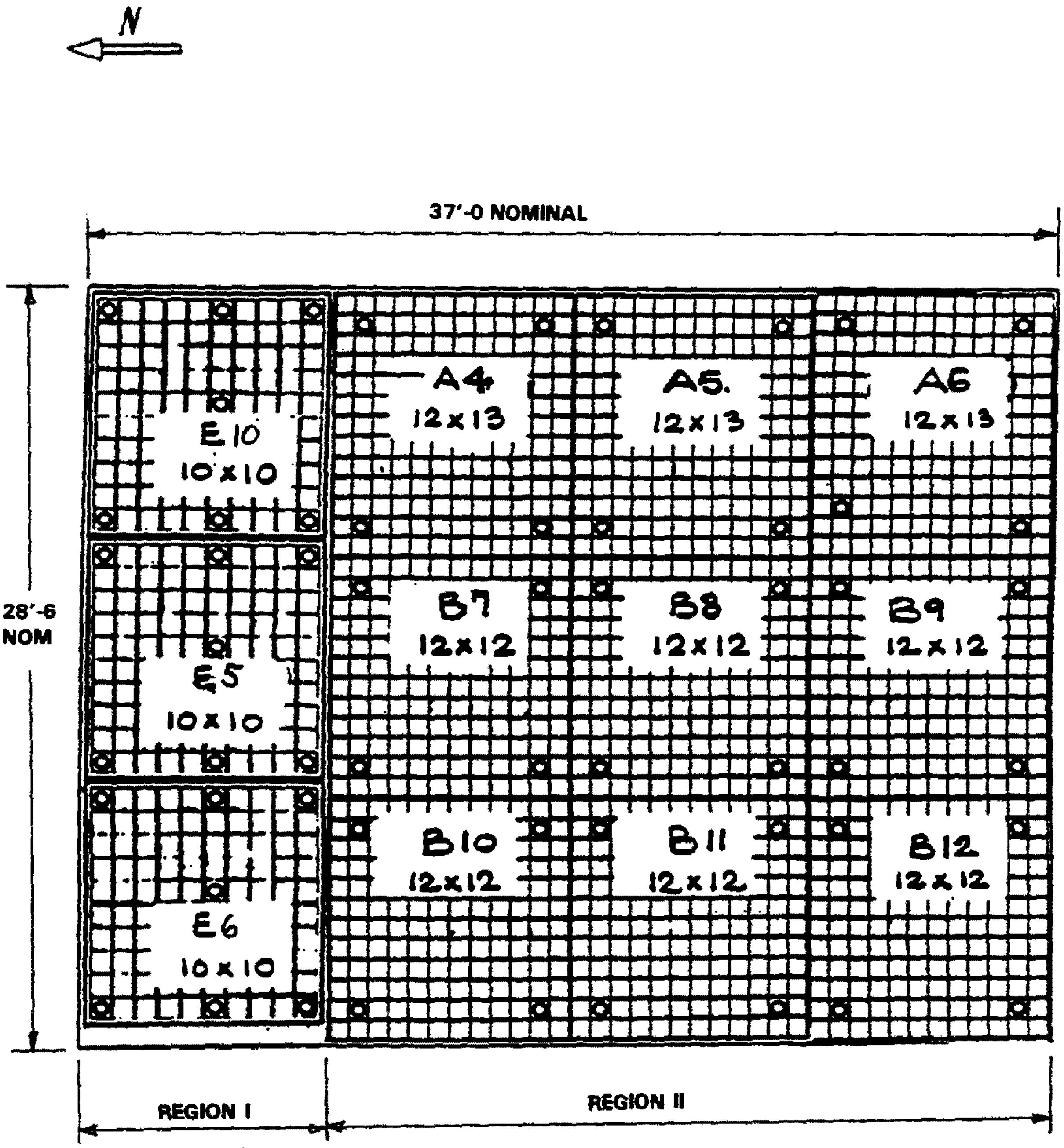


PUBLIC SERVICE ELECTRIC AND GAS COMPANY SALEM NUCLEAR GENERATING STATION	Maximum Density Region II Spent Fuel Storage Module	
	Updated FSAR Revision 15 June 12, 1996	Figure 9.1-2B



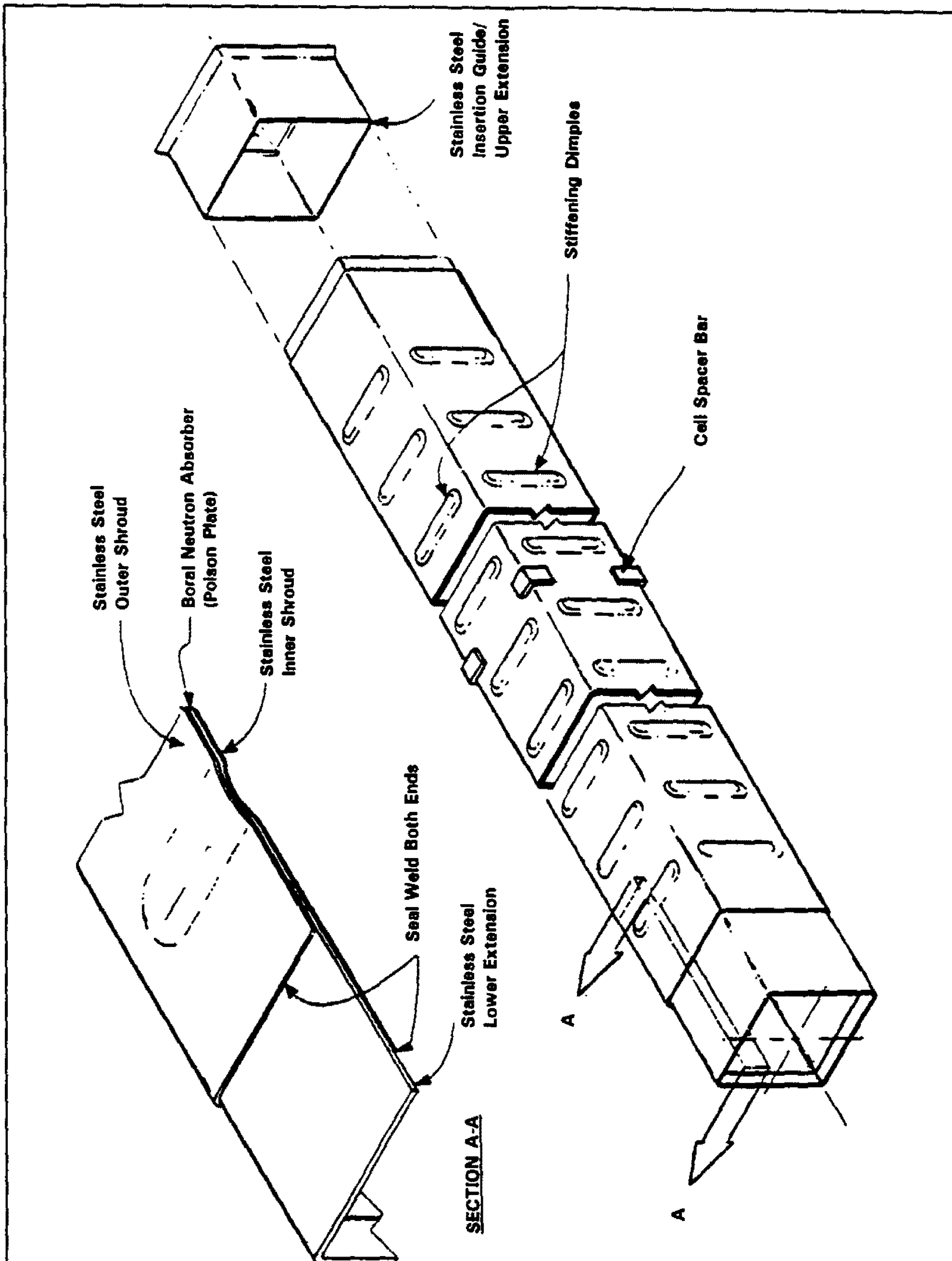
INCREASED CAPACITY POOL LAYOUT (1632 CELLS)

PUBLIC SERVICE ELECTRIC AND GAS COMPANY SALEM NUCLEAR GENERATING STATION	Unit 1 Spent Fuel Pool Rack Layout Updated FSAR Revision 15 June 12, 1996 — Figure 9.1-3

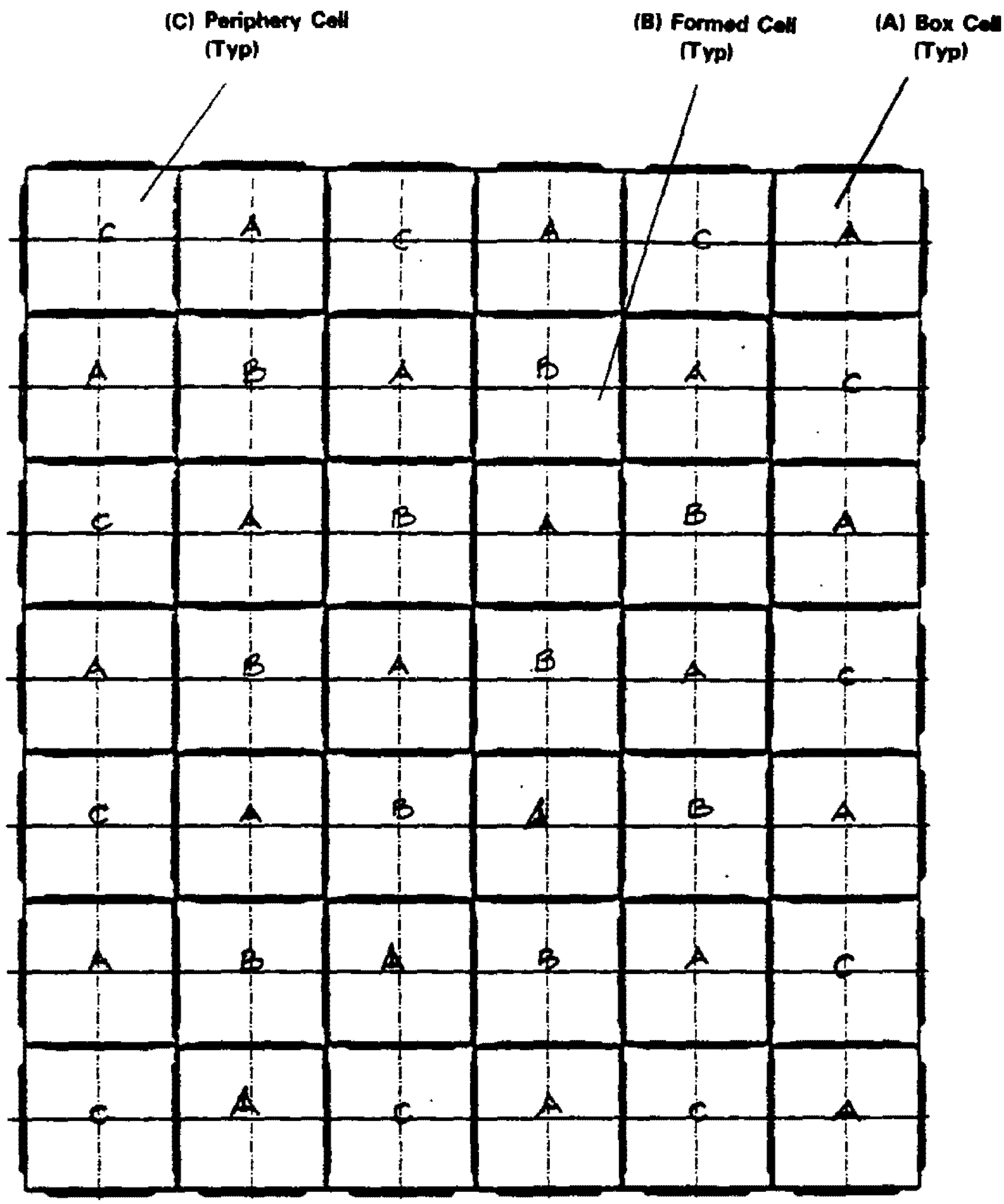


INCREASED CAPACITY POOL LAYOUT (1632 CELLS)

PUBLIC SERVICE ELECTRIC AND GAS COMPANY SALEM NUCLEAR GENERATING STATION	Unit 2 Spent Fuel Pool Rack Layout
	Updated FSAR Revision 15 June 12, 1996 — Figure 9.1-3A

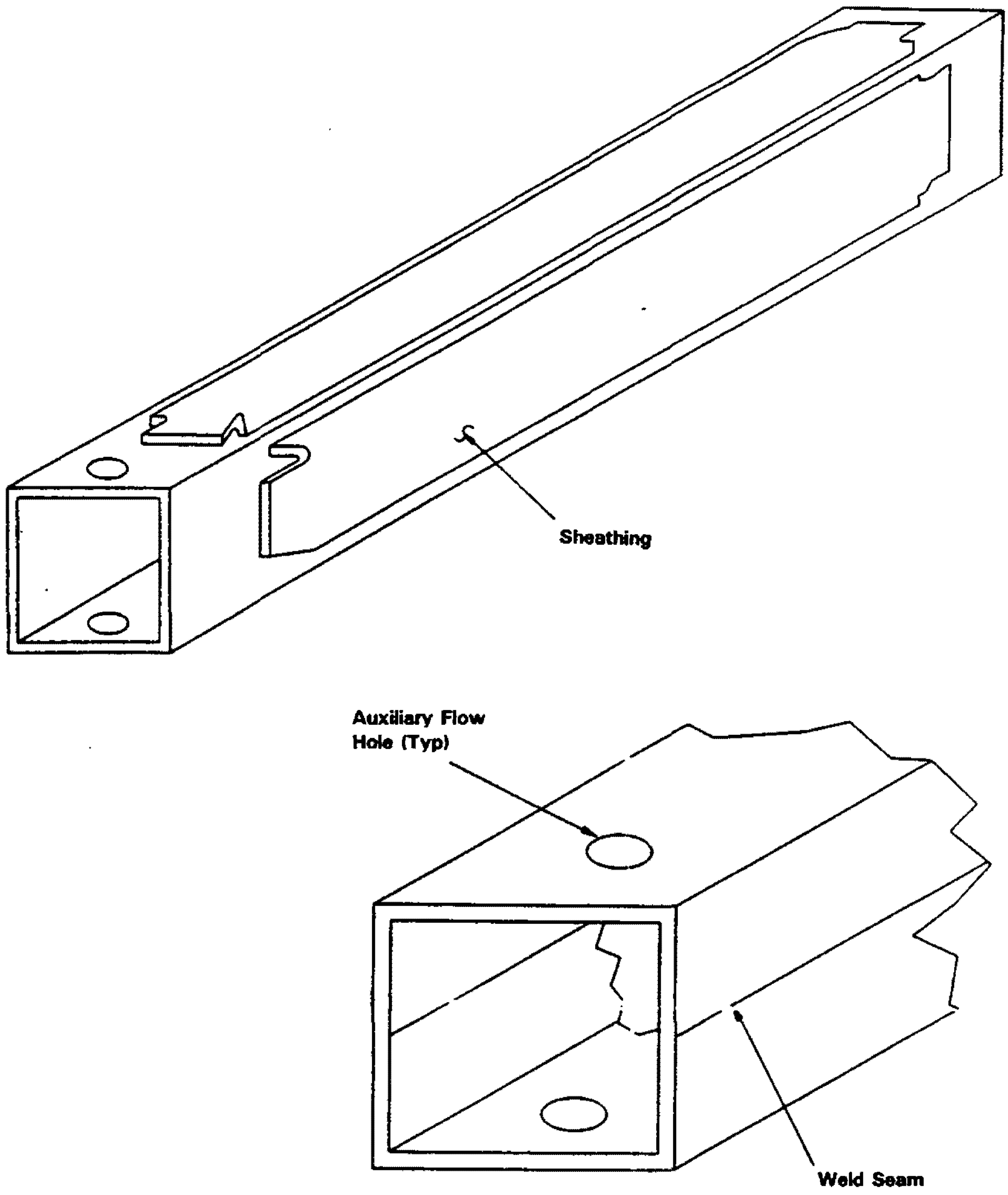


PUBLIC SERVICE ELECTRIC AND GAS COMPANY SALEM NUCLEAR GENERATING STATION	High Density Region I Poison Spent Fuel Storage Cell	
	Updated FSAR Revision 15 June 12, 1996	Figure 9.1-3B

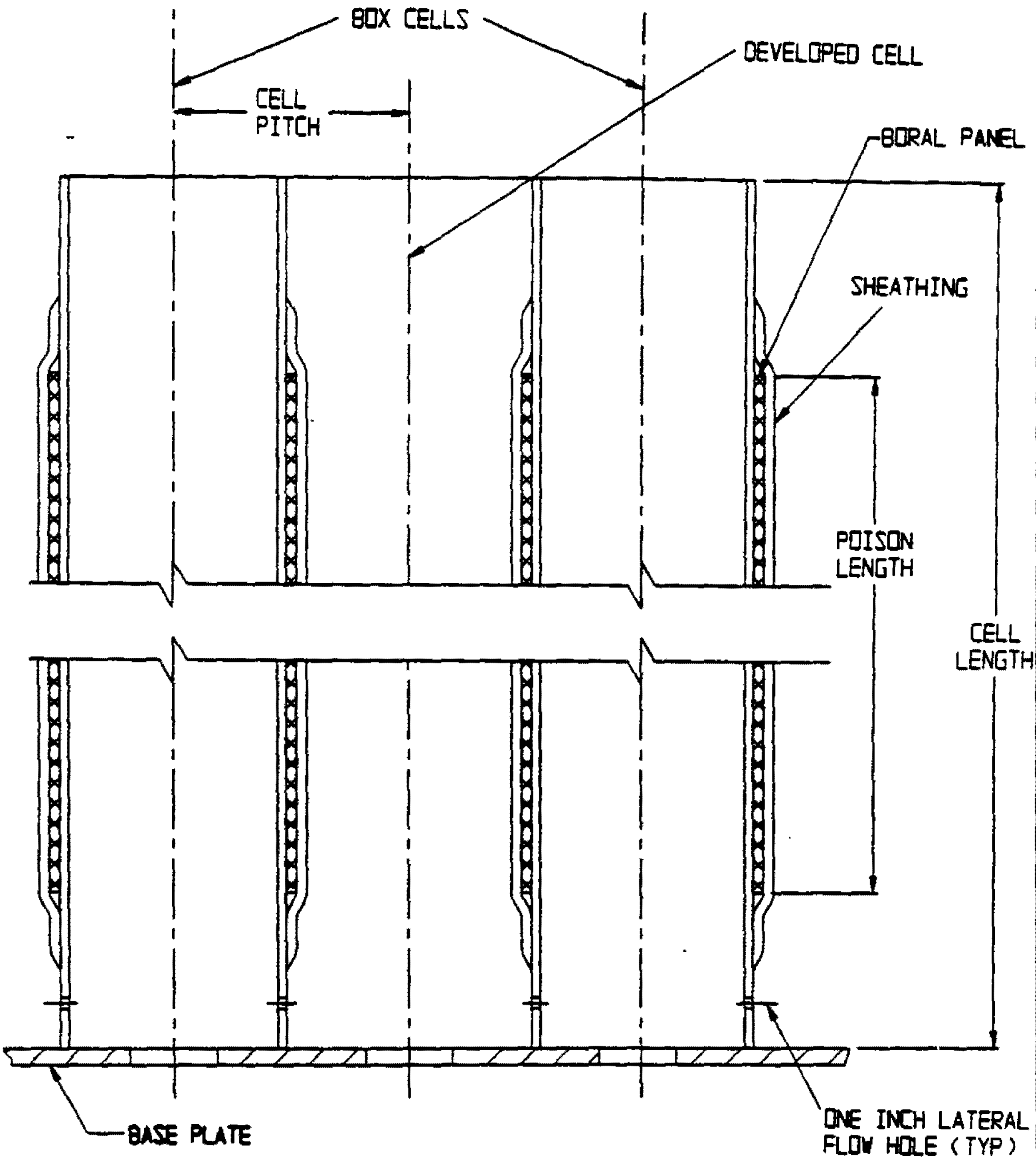


Typical Array of Region II Cells
(Non-Flux Trap Construction)

PUBLIC SERVICE ELECTRIC AND GAS COMPANY SALEM NUCLEAR GENERATING STATION	Maximum Density Region II Spent Fuel Storage Rack Array
	Updated FSAR Figure 9.1-3C Revision 15 June 12, 1996

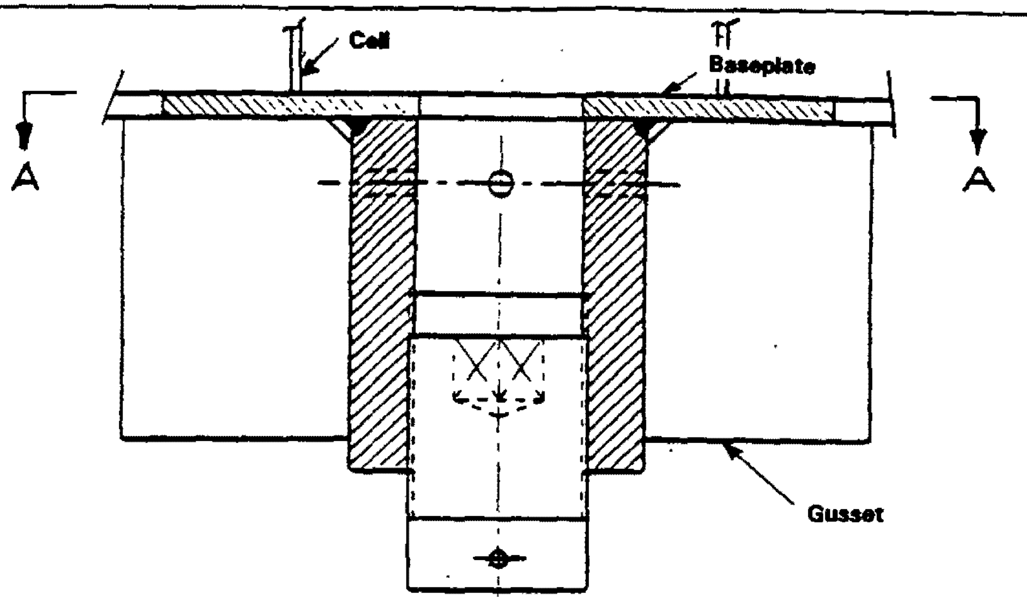


PUBLIC SERVICE ELECTRIC AND GAS COMPANY SALEM NUCLEAR GENERATING STATION	Maximum Density Region II Spent Fuel Storage Cell
	Updated FSAR Figure 9.1-3D Revision 15 June 12, 1996

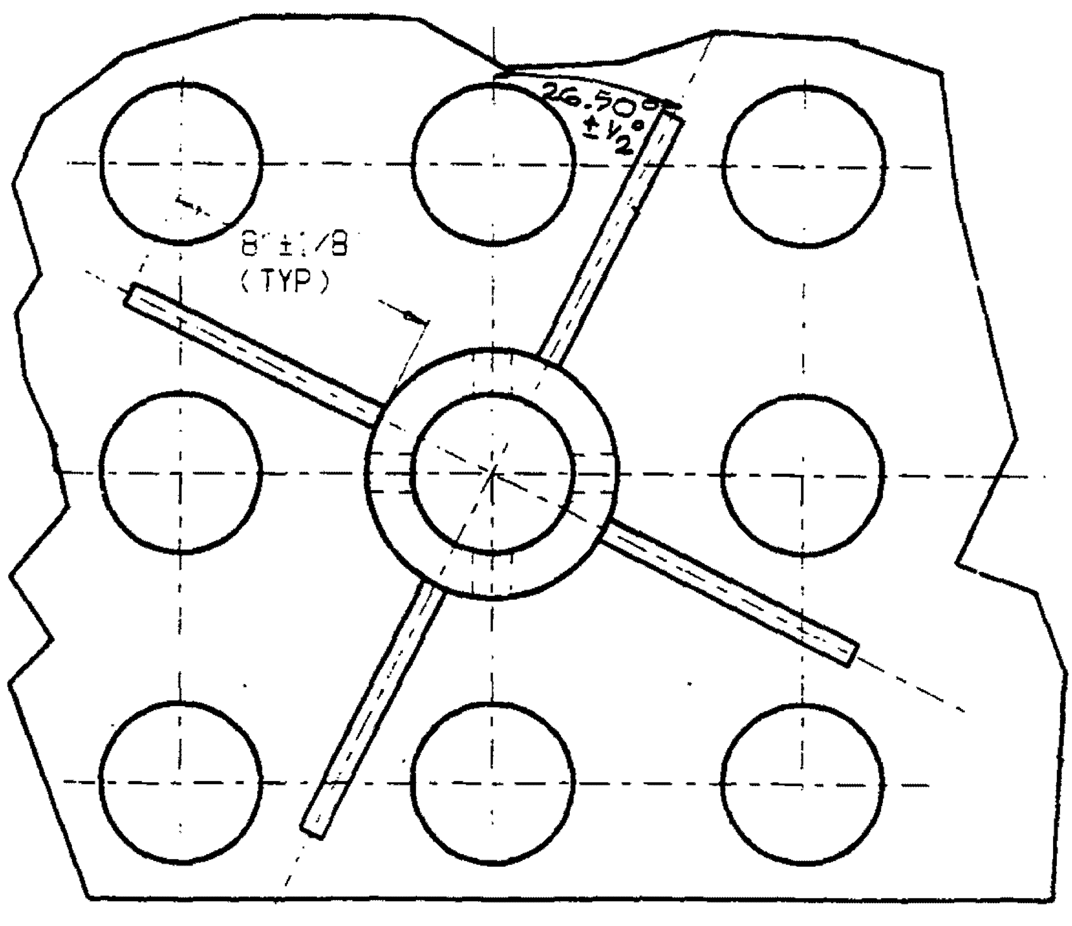


ELEVATION VIEW OF REGION II RACK MODULE

PUBLIC SERVICE ELECTRIC AND GAS COMPANY SALEM NUCLEAR GENERATING STATION	Maximum Density Region II Spent Fuel Storage Cell Cross Section
	Updated FSAR Figure 9.1-3E Revision 15 June 12, 1996



Elevation Through Baseplate and Support Leg



Plan A-A

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
SALEM NUCLEAR GENERATING STATION

Maximum Density Region II
Spent Fuel Storage Rack Baseplate

Updated FSAR
Revision 15 June 12, 1996

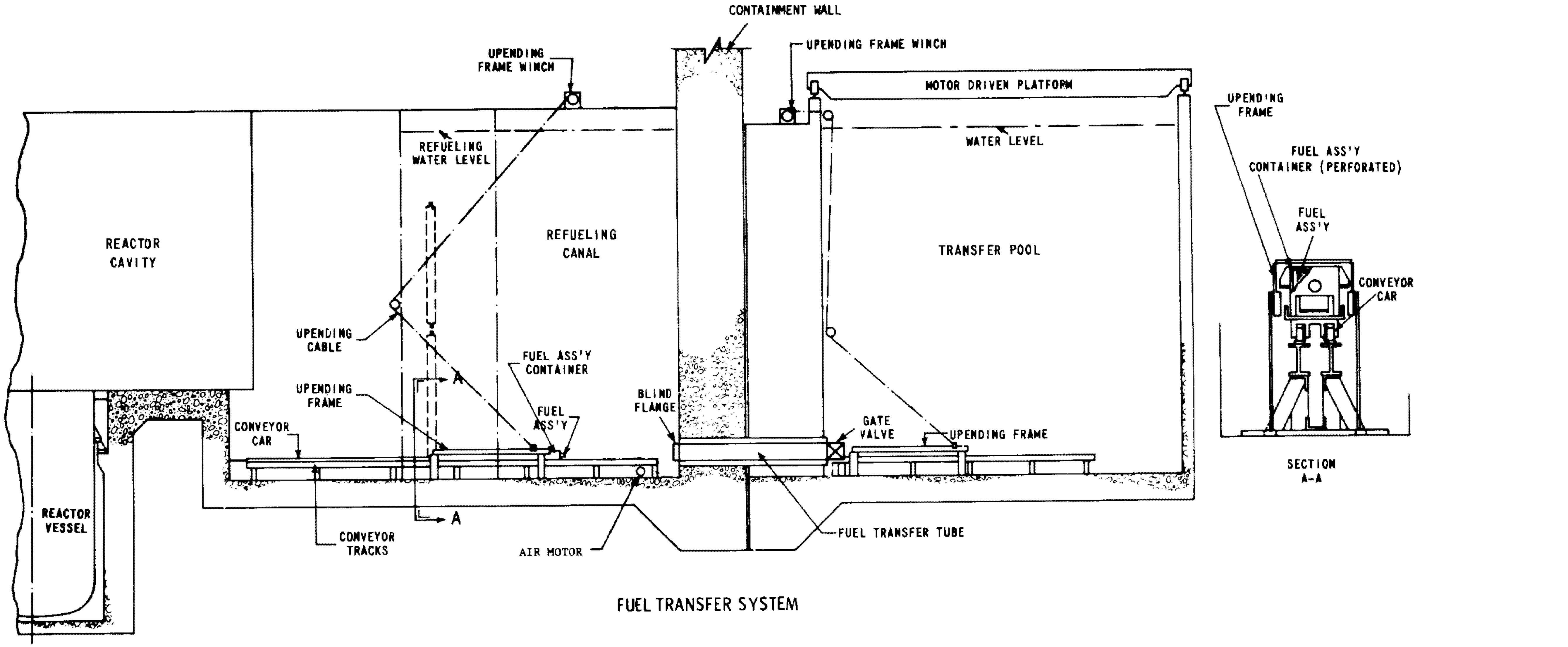
Figure 9.1-3F

Figure F9.1-4A intentionally deleted.

Refer to plant drawing 205233 in DCRMS

Figure F9.1-4B intentionally deleted.

Refer to plant drawing 205333 in DCRMS



FUEL TRANSFER SYSTEM

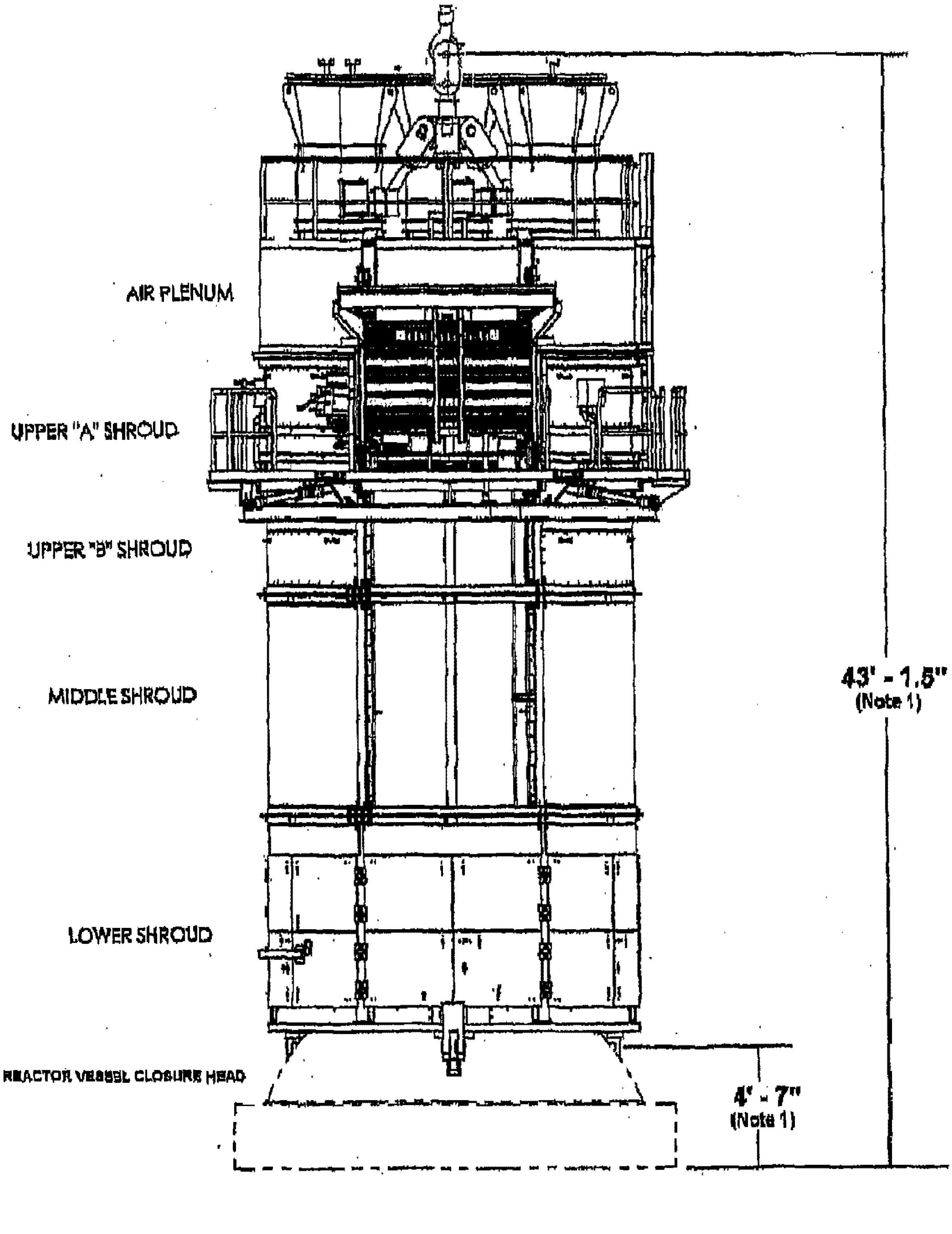
REVISION 6
FEBRUARY 15, 1987

PUBLIC SERVICE ELECTRIC AND GAS COMPANY SALEM NUCLEAR GENERATING STATION	Fuel Transfer System (Typical)
	Updated FSAR — Figure 9.1-5

FIGURE 9.1-6 HAS BEEN DELETED
(SEE FIGURE 9.1-6A)

Revision 22, May 5, 2006

PSEG Nuclear, LLC SALEM NUCLEAR GENERATING STATION	Salem Nuclear Generating Station REACTOR VESSEL HEAD & LIFTING DEVICE Updated FSAR Figure 9.1-6



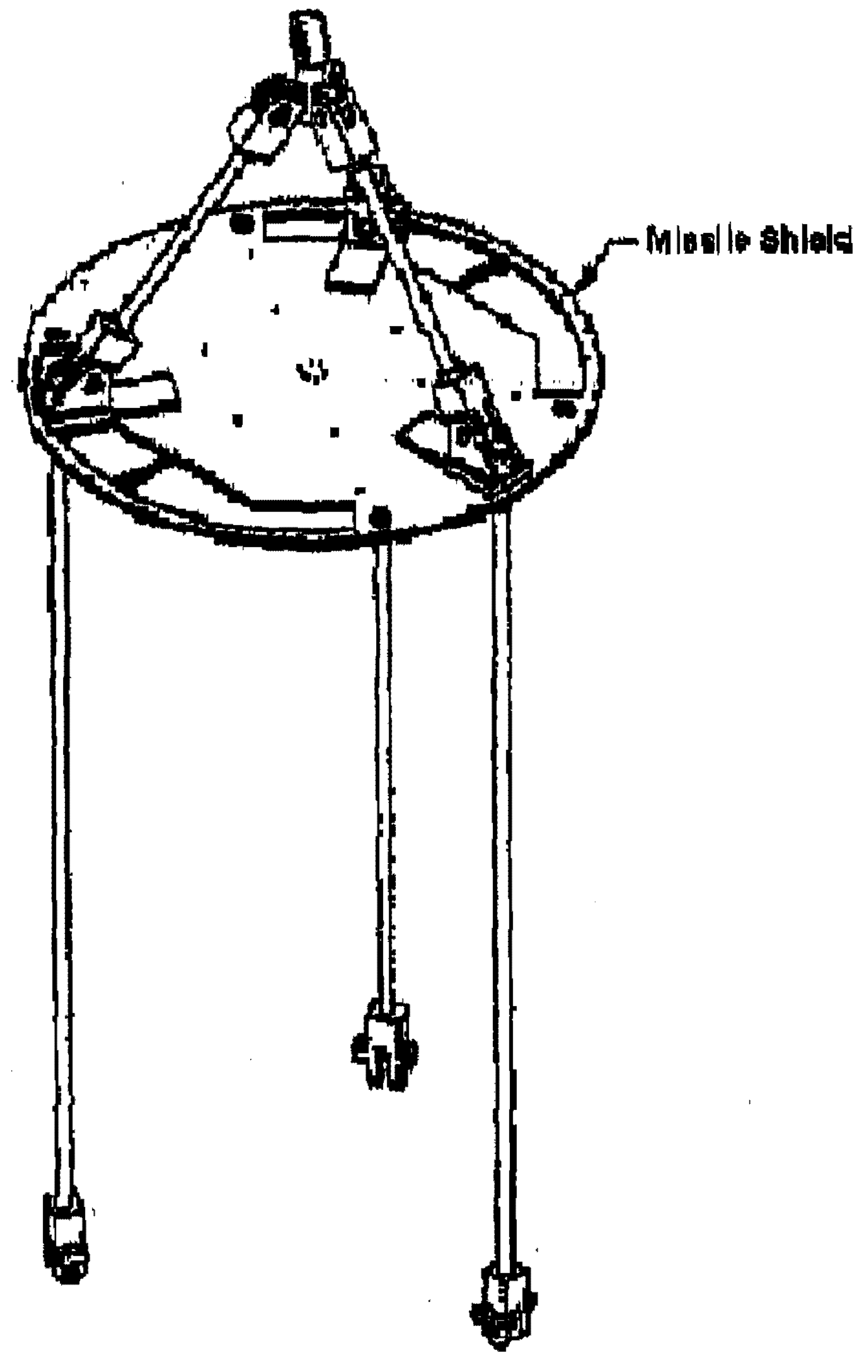
Revision 22, May 5, 2006

PSEG Nuclear, LLC SALEM NUCLEAR GENERATING STATION	Salem Nuclear Generating Station UNIT 2 IHA ASSEMBLY AND LIFTING DEVICES (LIFTING DEVICES: POLAR CRANE HOOK AND LOAD CELL LINKAGE)
	Updated FSAR — Figure 9.1-6A

FIGURE 9.1-7 HAS BEEN DELETED
(SEE FIGURE 9.1-7A)

Revision 22, May 5, 2006

PSEG Nuclear, LLC SALEM NUCLEAR GENERATING STATION	Salem Nuclear Generating Station MISSILE SHIELD
	Updated FSAR Figure 9.1-7



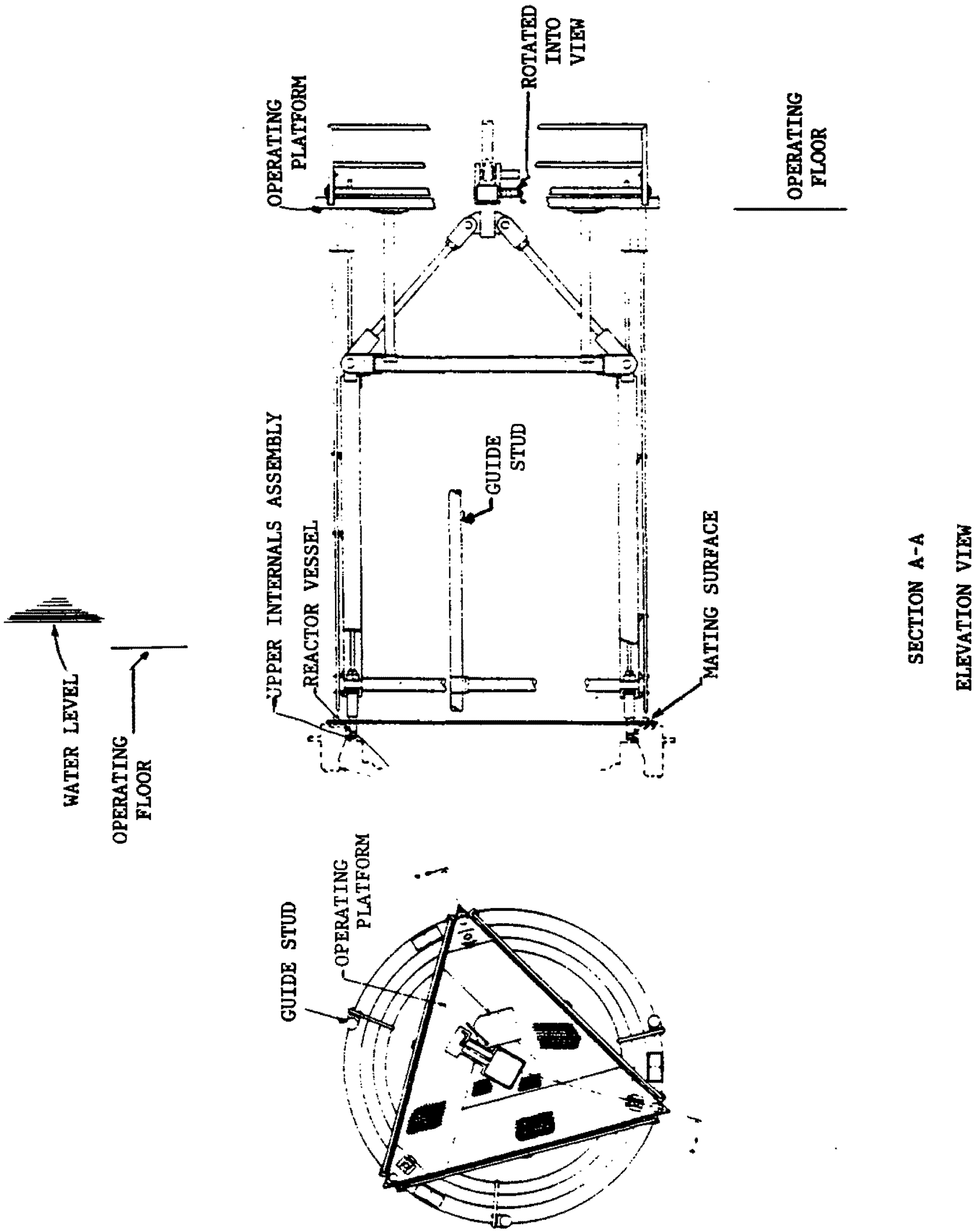
Revision 22, May 5, 2006

PSEG Nuclear, LLC SALEM NUCLEAR GENERATING STATION	Salem Nuclear Generating Station MISSILE SHIELD
	Updated FSAR Figure 9.1-7A

FIGURE 9.1-8 HAS BEEN DELETED
(SEE FIGURE 9.1-7A)

Revision 22, May 5, 2006

PSEG Nuclear, LLC SALEM NUCLEAR GENERATING STATION	Salem Nuclear Generating Station MISSILE SHIELD HANDLING FIXTURE
	Updated FSAR Figure 9.1-8



REVISION 6
FEBRUARY 15, 1987

PUBLIC SERVICE ELECTRIC AND GAS COMPANY SALEM NUCLEAR GENERATING STATION	Internals Lifting Rig	
	UPDATED FSAR	Figure 9.1-9

9.2 WATER SYSTEMS

9.2.1 Service Water System

9.2.1.1 Design Basis

The Service Water System (SWS) is designed to supply an adequate supply of cooling water to the reactor safeguard and auxiliary equipment under all credible seismic, flood, drought, and storm conditions. Coolant flow is divided into two portions, namely, the nuclear area and the turbine generator area. These are illustrated on Plant Drawings 205242, 205342 and 205312 and Figure 9.2-2A, respectively. The following equipment is supplied with the SWS.

Reactor Containment Building

Reactor containment fan cooler units.

Auxiliary Building

1. Component cooling heat exchangers
2. Diesel generator units
3. Chiller condensers
4. Auxiliary equipment lube oil coolers
5. Auxiliary equipment room coolers

Turbine Generator Building

1. Steam generator feed pump coolers
2. Station air compressor units

3. Turbine lube oil coolers

4. Turbine auxiliary cooling water heat exchangers

Pump Intake Structure

1. Traveling screenwash and strainer backwash

2. Service water pump bearing lubrication

3. Service water pump motor bearing coolers

4. Sodium hypochlorite dilution water

9.2.1.2 System Description and Operation

Each unit is equipped with six vertical turbine-type pumps which provide strained Delaware River Water to the plant before discharging via the circulating water outlet piping. The pumps for both units are installed in an enclosed intake structure which features four independent pump room compartments containing three pump units each. Each group of three pumps is valved into one of two independent, full-sized, supply headers per unit, which are situated in alternating compartments of the intake structure. Two 15,000 gallon pressurized storage tanks (10,000 gallon normal water volume) are connected to the SW piping downstream of the SW pumps. These normally-isolated tanks are designed to be rapidly placed in service through fast opening isolation valves in order to keep the CFCU SW piping solid following a Loss Of Off-site Power (LOOP) or a LOCA/MSLB concurrent with a LOOP event. A double-valved, normally open, interconnection between the two pump headers is provided to permit the continued operation of the system with any combination of pumps in the event of a supply line

outage. Each supply line to the nuclear services portion of the SWS normally feeds approximately 1/2 of the total nuclear area requirement for one unit. In addition, each line is valved at all terminations and provided with double-valved interconnections to permit the removal of either supply line from service without affecting plant operations. Recirculation control (to enable smooth multiple combination pump operation) is provided for each pump room compartment. Pump discharge is recirculated back to the pump intakes through a valve serving the three pumps within each compartment. These valves are modulated by service water pressure measured within the common manifold connecting the discharge of the three pumps within each compartment. Pump requirements on a per unit basis for various plant conditions are outlined as follows:

Plant Conditions	No. of Pumps
1. Normal Operation	4
2. Loss-of-Coolant Accident (LOCA)	
a. Safety Injection Phase	2
b. Recirculation Phase	3 (1)

(1) Minimum recirculation requirements can be met with two pumps.

Emergency diesel generators are provided to power three pumps during a failure of normal power supply. The total system requirements during various modes of plant operation are listed on Table 9.2-1 which lists the required pumping requirements based on a maximum river temperature of 90°F.

The reactor containment fan cooler (RCFC) units are supplied by individual lines from the containment area service water header. Each inlet and discharge line penetrating the containment wall is

provided with a remotely-operated, automatically controlled shutoff valve. This provision allows each fan cooler to be isolated on an individual basis from outside the containment area. Protection from thermally induced overpressure events in the RCFC coils is provided by the installation of bypass lines. These bypass lines are installed in each RCFC loop and discharge back into the SW system downstream piping. These bypass lines preclude overpressure conditions from developing in portions of the system during automatic valve sequencing.

The Service Water supply and return piping for each RCFC loop contain two restricting orifices (four total for each RCFC) which establish flow during normal and accident modes to meet minimum RCFC containment heat removal capacity. Orifice bore sizes were calculated based on minimum flow requirements established under worst case pressure/temperature conditions to prevent flashing in the Service Water System during post accident operation. The orifice sizes were selected to provide the ability to perform a high flow flush of the RCFCs by starting additional Service Water Pumps (increasing header pressure) to prevent silt deposition. An air-operated valve with adjustable open limit stop downstream of the last orifice on the return side exists for final flow adjustment. The RCFCs will start in low speed during the accident mode of operation.

The diesel generators can be provided with service water for cooling from either nuclear supply header through connections located upstream of the Auxiliary tie valves. Each nuclear header connection to the diesel generator coolers is provided with a normally open motor-operated isolation valve inside the Auxiliary Building, as indicated in Plant Drawing 205342. Either of the motor-operated isolation valves can be closed by the operator from the Control Room. Downstream of the motor-operated isolation valves, each service water supply and return header connections to each diesel generator cooler are provided with normally open manually operated inlet and outlet valves and check valves.

Rupture of the Service Water piping in this area will result in leakage into the Diesel Fuel Oil Storage Tank rooms or the Cardox Storage Tank room. The Diesel Fuel Oil Storage Tank rooms are designed to contain a Fuel Oil leak and have no drains. Any leakage in these areas will fill the room to the curb elevation (Approximately 40") and spill back into the Cardox Storage Tank Room. The Cardox Storage Tank Room has no drains and therefore any leakage into this area will run out into the Auxiliary Building and into the Auxiliary Building Drain System.

The maximum postulated leak rate from a crack in this piping will not affect the ability of the Service Water System to provide sufficient flow to all components. Operations will become aware of the leakage indirectly based on increasing sump levels. Action on this leakage will be based on increasing radwaste inventory rather than loss of function of Safety Related equipment. Onsite identification of the location of the leak will be required to determine which valves must be closed to isolate the leak. As required, either header can be isolated by closing the motor-operated isolation valve, or an

individual diesel can be isolated by closing the manual inlet and outlet isolation valves. As required, the affected Diesel generator can be unloaded and shutdown. Note that the manual isolation valves are all accessible and are located above the maximum flood elevation in Fuel Oil Storage Tank Room permitting operator access and identification.

Failure of one of the nuclear supply headers downstream of the tie valves in the Auxiliary Building will not interrupt the supply of service water to the equipment required to operate following a LOCA. Each of the two service water loops provides service water to one component cooling heat exchanger, one charging pump lube oil cooler, one safety injection pump lube oil cooler, and three containment fan cooler units.

Each service water nuclear discharge header crosses the yard and enters a 120 inch diameter circulating water discharge pipe, which discharges directly to the Delaware River. An evaluation has demonstrated that the water discharge function of the circulating water discharge piping will be maintained during and after a postulated design basis event. Thus, a postulated seismic event will not interrupt the service water discharge from the plant.

An access manway for personnel egress and isolation valve is installed in the buried SW discharge headers near the tie-in to the CW piping allowing for the headers to be dewatered for inspections. Concrete missle shield vaults with steel covers are provided to protect the access manway and valve operator reach rod assembly from tornado-generated missiles. These missile shields meet the requirements in Section 3.5.2.2 to withstand applicable tornado missiles as defined in Section 3.5.2.1 of the UFSAR.

The safety related auxiliary building pump room and lube oil coolers are fed by two independent room/lube oil cooler headers. Each of these headers is normally supplied from one of the two main service water headers.

In the event that one main header is out of service downstream of the Auxiliary Building tie-valves, normally locked closed cross-connections provide the ability to operate both the room/lube oil cooler headers from the remaining operational main header.

The cross connect consists of supply and return branches. These branches are located upstream and downstream of the component cooling heat exchangers in the component cooler heat exchanger rooms, and are sized to allow for acceptable flow to meet the design requirements for all the coolers in use with only one main service water header available.

The service water pumps are of the vertical, multistage, turbine type, each rated at 10,875 gpm and 265 foot head, and directly driven by 1000-hp induction motors powered from the plant vital buses. Administration control may be required to maintain pump performance at a higher level in order to ensure acceptable system margins. The pumps for each unit are mounted in two individual dewaterable cells of the intake structure with three pumps to a cell. The intake structure, shown on Plant Drawing 211612, is physically apart from the turbine condenser circulating water pump intake. The pumps are arranged to afford adequate submergence during the lowest credible water level elevation of 76.0 feet. The motors are protected from flooding by the pump room compartments which are watertight to Elevation 126'-0" with wave run-up protection to Elevation 128'-0", and which contain sump pumps. Automatic traveling water screens are provided at each intake cell and combine with full-depth trash racks to filter debris from the incoming flow. Trash racks are inspected and cleaned periodically to maintain unobstructed passageways at the trash racks. Two-foot-wide fish-escape passages are located abreast of the traveling screens to minimize the entrapment of fish in the individual intake cells. The primary method to prevent organic buildup in the heat exchangers and piping is by injecting sodium hypochlorite into the suction of each service water pump. In addition, the system provides for injection of sodium hypochlorite downstream of the SW strainers when conditions require the SW strainers to be placed in continuous backwash operation. Each pump discharges to an automatic, self-cleaning strainer and check valve prior to entering the compartment supply header.

The SWS intake structure is located about 200 yards from the Delaware River shipping channels. It is expected that shipping will not approach the intake since the channel is marked by buoys and lights. Due to the large distance between the intake and the shipping channel, vessels which may be adrift can be secured, anchored, or grounded before coming into the vicinity of the intake. In the event that small unattended barges do drift into the vicinity of the intake, marine dock bumpers have been installed to prevent damage to the structure.

The six service water pumps for each unit are arranged in groups of three pumps each, and each group of pumps for one unit is installed in alternate watertight compartments inside the intake structure, as indicated on Plant Drawings 205242 and 205342. Each service water pump is recessed approximately 50 feet from the river face of the intake. Based on the above, damage or blockage to two adjacent compartments of the intake can occur without cutting off the supply of service water to each unit.

In the event that a river borne oil spill occurs which could affect the service water intake, floating oil spill booms will be installed as needed to protect the two end cell fish-escape passages opening to the river to prevent oil from entering the intake at any river water level above 81 feet. A curtain wall at Elevation 81 feet extending across the entire intake structure, except in the fish escape passages, prevents any oil from entering the intake at any river level above this elevation. Lowest recorded river water level is 83 feet-1 inch. The vertical turbine type service water pumps take suction at Elevation 71'-6" for Johnston Pump Co. pumps, which is below the minimum credible river water level of 76 feet. Based on the above, oil floating on the river surface will not be drawn into the pumps. Should the river water level drop below elevation 81 feet with water borne oil present, the plant would be shut down.

The SWS is designed for Class I (seismic) conditions except for the turbine area service water piping outside of the service water intake structure, which is of non-Class I (seismic) design. The Class I (seismic) service water piping inside the service water intake structure which supplies the turbine area is provided with two motor-operated valves, SW-20 and SW-26, in series, to isolate the non-Class I (seismic) portion of the system upon receipt of a safety injection signal or a loss of off site power. The two motor-operated valves in series are powered from separate vital buses to ensure isolation of the non-Class I (seismic) portion of the SWS.

The hypochlorite system piping inside the service water intake structure is designed for Class II (seismic) conditions, but the pipe supports are designed to Class I (seismic) criteria.

The separated redundant service water lines between the service water pumps and the Unit 1 component cooling heat exchangers are not located in open trenches as such, but rather are constructed of reinforced concrete pipe completely buried in the ground. Thus, in effect, they are located in "separate trenches." The principal supply line piping runs are separated by about 13 feet. This separation, in conjunction with the depth at which they have been buried, makes these lines essentially invulnerable to damage from a single postulated event.

The above discussion also applies to the service water piping to the Unit 2 component cooling heat exchangers except for one section of piping running along the west side of the Auxiliary Building. Though not buried, this piping is located within a 4 foot-6 inch thick reinforced concrete pipe tunnel. The redundant supply lines within the tunnel are separated by a 3-foot thick reinforced concrete wall, again precluding coincident failure due to a single event.

Status is displayed and control of each service water pump is available on the main control panel so that an operator can determine if an abnormal number of pumps is operating. In addition, indication of the 14 and 24 pump in "TEST" is displayed on the auxiliary annunciator during performance of surveillance testing. Status and control of all SWS isolation valves and motor-operated header block and tie valves is also available to the operator in the Control Room. The motor-operated valve operators (with the exception of the Turbine Area isolation valves) complete their closing or opening cycle in 1 minute while the containment isolation valves can close in 10 seconds. The Turbine Area isolation motor operated valves have a more rapid operating time of a maximum of 37 seconds.

The rupture of a large pipe or other event causing a high system flow demand will be indicated to the operator by decreasing pump header pressure shown on the main control panel. Low pump header pressure will be alarmed to the main control room. If pump discharge header pressure continues to fall, and outside power is available, a backup service water pump will start automatically.

Each SWIS pump compartment contains a sump whose nominal capacity is 49 cu. Ft. (366 gal.), and each has a sump pump capable of removing over 250 gpm. In the event that a pipe rupture occurs in a watertight pump compartment in the service water intake structure, which is beyond the capacity of the sump pump, high sump level for the affected compartment will be alarmed to the Control Room. The Control Room operator can remotely close the tie valves and header block valves at the intake structure to isolate the affected compartment and remotely start the remaining pumps in the other pump compartment to permit an orderly plant shutdown.

In the event that a main yard supply header is ruptured, the affected header can be isolated by the Control Room operator who can also open the tie valves at the Auxiliary Building. Rupture of a header pipe for Unit 2 in the pipe tunnel can also be detected by high level to the Control Room alarm from the sumps containing a 100 gpm pump. The Control Room operator can determine the affected header by remotely closing the intake tie valves and observing which pump header is affected by low-low pressure. Once the rupture yard header is isolated, the intake tie valves can be opened and all service water pumps made available.

Service water piping in the Auxiliary Building is, for the most part, accessible during operation for inspection by the operators.

Generic Letter (GL) 96-06 was issued by the NRC to notify utilities of safety significant issues that could affect containment integrity and equipment operability during accident conditions. The SW system is designed to withstand the effects of events described in GL 96-06. These GL concerns of thermally induced overpressure, the development of two-phase flow regions, and column separation or voiding leading to the possibility of waterhammer events are addressed by system modifications.

A pressurized tank in each of the two service water headers is installed to serve the containment fan cooler unit (CFCU) loops. The supply lines between the tanks and the SW headers have fast opening valves to allow flow in the event of a LOOP (Loss Of Off-site Power) or LOOP/LOCA. The tanks have a volume of 15,000 gallons each and are pressurized with nitrogen, and discharge into the SW system upon a loss of off-site power. The vessels are sized to contain sufficient water inventory to keep the SW piping full for all postulated operating and single failure conditions. A separate building houses the storage tanks, piping and the storage tank instrumentation and controls.

Each storage tank has non-safety related redundant level, temperature and pressure instruments. Local instrumentation will include level, temperature, and pressure indications. The main control room is provided with a common "tank trouble" overhead annunciator and an individual alarm for each storage tank. The non-safety related classification is considered acceptable on the basis that critical system parameters are periodically monitored during normal operation to assure operational readiness of the system. During normal operations and following a LOOP, the supply tanks are filled by a makeup water pump located at each storage tank. The pumps are manually controlled and are supplied from the SW system.

The storage tank discharge valves are air operated butterfly valves designed to spring open rapidly upon a Loss of Offsite Power. The valves are powered from redundant safety related 125 VDC channels and are designed to be energized to open and fail closed on a loss of control power. This design assumes one of the two flow paths for each tank will be operable while ensuring against spurious operation. Air is required to close the valves. Redundant undervoltage relays installed on the 4KV vital buses are combined in a 3 out of 3 logic to energize the valve solenoid, venting air from the operators to open the valves.

Bypass lines are installed to protect from thermally induced overpressure events in the CFCU piping. These bypass lines are installed in each CFCU loop and discharge back into the SW system's downstream piping.

In the event that a pipe rupture occurs in the service water piping inside the containment, high level alarms in the containment sump and the fan cooler drain pot will be transmitted to the Control Room. The Control Room operator can remotely close the containment isolation valves to isolate the leaking fan cooler unit.

THIS PAGE INTENTIONALLY BLANK

In the event that radiation is detected at one of the service water outlets from the containment, the condition is alarmed in the Control Room. The final decision to isolate the coils is based on plant conditions, analyses, and indications.

The service water flow through the containment fan cooler units is indicated on the control console.

A temperature detector monitors the fan cooler outlet temperature, which is indicated on the control console; high water temperature could be an indication of inadequate flow.

The service water flow through each Component Cooling Heat Exchanger is normally controlled by means of a cascade control system which simultaneously throttles both the inlet and outlet control valves with a common control air signal. The valves are throttled to maintain component cooling water outlet temperature as the primary parameter, and flow will be limited to a nominal operating value of 10,000 GPM as the secondary parameter. The Service Water flow can be controlled manually in order to establish the desired Component Cooling outlet temperature. The indicating valve control system is mounted on an instrument panel which is located in the Auxiliary Building in the vicinity of the heat exchanger. In addition, a flow transmitter alarms a service water high flow condition on the overhead annunciator in the Control Room.

In certain post-accident alignments, available system pressure will be limited such that the Component Cooling Heat Exchanger original design flow of 10,000 gpm may not be attainable for both heat exchangers. As noted in Table 9.2-1, the currently evaluated design (minimum required) flow has been defined to be 8,000 gpm with 90° F water. The capability of meeting or exceeding this flow, where required, is demonstrated in detailed system calculations.

Material inspection, fabrication, and quality control conform to ANSI B31.7. Where not possible to comply with ANSI B31.7, the requirements of ASME III-1971, which incorporated ANSI B31.7, were adhered to. In addition, the weld inspection criteria of later Editions and Addenda of ASME III, as approved by the NRC, can be specified.

Radiographs of Nuclear Class 3 cement-lined pipe were difficult to interpret. The 1970 addenda to B31.7 allowed 100-percent magnetic particle inspection in lieu of random radiography. This provision was also incorporated into Section III, 1971 Edition. The SWS contains Nuclear Class 3 cement-lined pipe for which this alternate inspection method was utilized. In addition, the weld inspection criteria of later Editions and Addenda of ASME III, as approved by the NRC, can be specified.

For the original cement lined piping the use of a later code was restricted to inspection and did not involve any requirements from Section III such as material, stress calculations, etc., that would modify our original design. Consequently, other requirements from a later code would not be applicable. Therefore it is believed that the integrity of field welds has not been compromised and that we have complied with our commitment to use ANSI B31.7 whenever possible. In addition, the weld inspection criteria of later Editions and Addenda of ASME III, as approved by the NRC, can be specified.

As part of a reliability improvement program, replacement of portions of the system piping was initiated in 1988 for both Unit 1 and Unit 2. The replacement material selected after an extensive qualification program is a 6% molybdenum Austenitic Stainless Steel, which is furnished to the material requirements of the ASME code Section III, Division 1. However, fabrication, inspection and installation of this piping material is in accordance with ANSI B31.7 and therefore compliance with the commitment to utilize ANSI B31.7 wherever possible has again been maintained. In addition, the weld inspection criteria of later Editions and Addenda of ASME III, as approved by the NRC, can be specified.

In order to provide enhanced accuracy and repeatability for periodic ASME Section XI performance testing, a full flow Service Water Pump surveillance test line was added to the Service Water Intake

Structure by DCP 1EC-3047 in 1991. This line is connected to the Unit 1 Service Water pipe at the 30" crossover line between the SW17 valves in a section of pipe located in bay #2 (Ref. Plant Drawing 205242) and into the Unit 2 Service Water pipe at the 30" crossover line between the SW17 valves in a section of pipe located in bay #3 (Ref. Plant Drawing 205342). These connections are 16" in size and are connected to two 16" butterfly valves which are normally closed. The 16" lines reduce down to 12" lines and penetrate outside the east wall of the Intake Structure through watertight seals. Outside the wall the two lines connect together and run around to the north wall. The line expands to 20" for the flow measuring section which has a long straight run that is essential for the flow measurement element located along the north wall. The line then runs through a butterfly valve used for initial filling prior to each flow test and exhausts to the Trash Basket back to the river. The two 16" butterfly valves provide double isolation and form the boundary between the safety related and non-safety related portions of the line. All the supports on this line are designed to Seismic Class I criteria.

The surveillance line provides the capability to accomplish a performance test for each individual Service Water Pump utilizing a direct recirculation flow path around the Intake Structure through a high accuracy flow element that is independent of the rest of the plant.

9.2.1.3 Design Evaluation

The SWS is designed to remain operable under each of the following conditions:

1. Any one pump failure and one pump under maintenance

2. Any one pump failure and two pumps under maintenance provided that:
   1. No more than one pump per intake bay is removed from service, and
   2. No more than one pump per vital bus is removed from service

3. One main supply header failure

4. Loss-of-coolant accident coincident with loss of offsite power and subsequent 4-kV vital bus failure.

5. Failure of components such as individual valves that receive active control signals to change position or modulate are addressed as single active failures.

   Updates to the design evaluation were made in 1997 to address GL 96-06 concerns relative to maintaining the containment cooling portions of the system free of voids or column separations, above saturation pressure and protected from thermally induced overpressure. In order to support these updates, positions were established based on the design and licensing basis of the Service Water System regarding certain types of single failures. The key positions are identified below:

   a. The failure, or spurious actuation of a remotely operated, manually controlled, or power operated (i.e., either air or motor) valve that does not have any automatic actuation signal is not considered to be a credible failure.

   b. Failures of check valves to move to their intended position following an accident scenario are considered passive failures.

The minimum engineered safeguards equipment required to safely shut down the unit will not be limited by any of these failures.

As part of the GL 96-06 modifications, RCFCs are maintained free of voids or column separation, above saturation pressure, and protected from thermally induced overpressure events during all normal operating and abnormal events.

9.2.1.4 Tests and Inspections

The system was hydrostatically tested prior to station operation. All active components (valves, pumps, and controls) were functionally tested prior to startup. Surveillance requirements for inservice inspection and testing of components are in accordance with the Technical Specifications.

9.2.2 Component Cooling System

An independent Component Cooling System, shown on Plant Drawings 205231 and 205331, is provided for each unit. All information in this section refers to one unit. Unit 2 is of a similar design.

9.2.2.1 Design Bases

The system is designed to remove residual and sensible heat from the Reactor Coolant System (RCS) via the Residual Heat Removal (RHR) System during plant shutdown, cool the spent fuel pool water and the letdown flow to the Chemical Volume and Control System (CVCS) during power operation and provide cooling to dissipate waste heat from various primary plant components. The design of the Component Cooling System is based on a maximum service water supply temperature of 90°F.

Active system components which are considered vital to the cooling function are redundant. Redundancy of components in the Component Cooling System, when provided, does not degrade the performance or reliability of any system which the Component Cooling System serves. Any single active or passive failure in the system will not prevent the system from performing its design function.

The system design provides means for detection of radioactivity entering the system from the RCS and its associated auxiliary systems and includes provisions for isolation of system components.

9.2.2.2 Codes and Classifications

All piping and components of the Component Cooling System will be designed to the applicable codes and standards listed in Table 9.2-2. Component cooling water contains a corrosion inhibitor to protect the carbon steel.

9.2.2.3 System Description

The Component Cooling System consists of three component cooling pumps, two component cooling heat exchangers, a component cooling surge tank, cooling lines to various components being cooled, and associated piping, valves, and instrumentation. The component coolant flows from the pumps, through the shell side of the component cooling heat exchangers, shell and tube type, or through the component cooling water side of the component cooling heat exchangers, plate type, through the components being cooled, and back to the pumps. The surge tank is connected to the suction side of the component cooling pumps. Makeup water is supplied to the loop near the surge tank.

During normal full power operation, one or two component cooling pumps and one component cooling heat exchanger accommodate the heat removal loads. The standby pump and the standby heat exchanger provide backup during normal operation. Operation of all component cooling pumps and both component cooling heat exchangers is required for removing residual and sensible heat during a normal plant shutdown. Failure of one of these components increases the time required for shutdown but does not affect the safe operation of the plant.

In the event of a LOCA one pump and one heat exchanger are capable of fulfilling system requirements. Three main cooling headers are provided: two isolable headers which supply cooling water to essential safety equipment, and one header which supplies cooling water to the other plant auxiliaries. With this arrangement, long-term cooling of the Engineered Safety Features under accident

conditions is assured considering an active component failure or the development of excessive leakage in one header in the Component Cooling System. Cooling water for the component cooling heat exchangers is supplied from the SWS insuring a continuous source of cooling under all conditions.

Component cooling is provided for the following heat sources:

1. Residual heat exchangers

2. Reactor coolant pump motor bearing oil coolers and thermal barriers

3. Letdown heat exchanger

4. Excess letdown heat exchanger

5. Seal water heat exchanger

6. Spent fuel pool heat exchanger

7. Sample heat exchangers (Unit 1 Component Cooling System serves the sample heat exchangers for both units.)

8. Boric acid evaporator condenser and condensate cooler

9. Cooling for residual heat removal, safety injection, and charging pumps

10. Waste Disposal System components

Design flow rates under various conditions are tabulated in Table 9.2-3.

All components served are arranged in three main headers with parallel flow circuits from each header. Cooling water is normally available to all components served by the system, even

though one or more of the components may be isolated. Motor-operated valves are used to provide the residual heat exchangers with cooling water should it become necessary to place these components in service under LOCA conditions. At the reactor coolant pump, component cooling water removes heat from both the motor bearing oil and the thermal barrier.

The Component Cooling Water System is considered an Engineered Safeguards System, since it is required for post-accident decay heat removal. For that reason, it is designed to meet the single active or passive failure criteria. Two mechanical safety trains are provided, each of which is capable of satisfying the system safety function when operated independently. The mechanical safety trains are normally cross connected, with safety related heat loads split between the two trains. Each train is supplied by a common pump discharge header. Flow is through the CC Heat Exchangers, and then through parallel flow paths to the safety related heat loads. Return flow from each train is through separate piping into a common suction header. Three safety related pumps are provided. Each pump is powered from separate vital buses and discharges into a common discharge header. The pumps and associated heat exchangers are installed in two separate rooms on elevation 84 ft. in the Auxiliary Building. The surge tank is located on elevation 120 ft. in the Auxiliary Building, and is divided into two sections by a baffle. The tank sections are connected via independent piping runs to each train's return line. Following an accident, the Control Room operator evaluates the status of available equipment and if necessary, manually realigns the system to assure heat removal requirements are satisfied. Redundant remote motor-operated valves, operated from the control room, are provided to allow the operator to accomplish any required system alignment, such as establishing two independent safety trains when necessary. This compliment of equipment provides sufficient redundancy to assure that the system safety function is maintained following the most limiting single electrical or mechanical failure.

Since the heat is transferred from the component cooling water to the service water, the Component Cooling System serves as an intermediate system between the RCS and the SWS and insures that any leakage of radioactive fluid from the components being cooled is contained within the plant. The surge tank accommodates expansion, contraction, and in-leakage of water and insures a continuous component cooling water supply until a leaking cooling line can be isolated. Radiation monitors are provided on the component cooling heat exchanger discharge lines. The monitors actuate alarms and close the surge tank vent valve when the radiation level reaches a preset level above the normal background.

Water chemistry control of the Component Cooling System is accomplished by chemical additions to the surge tank and by addition of demineralized water to the system through two lines connected to the suction header of the pumps.

The operation of the system is monitored with the following instrumentation:

1. Temperature detectors in the inlet and outlet lines for each component cooling heat exchanger

2. Pressure detectors on the pump discharge headers

3. A temperature indicator in the outlet line from each heat exchanger

4. A radiation monitor in each component cooling heat exchanger discharge line

5. A level indicator and alarm on each side of the surge tank

9.2.2.4 Components

Component Cooling System component design data are listed in Table 9.2-4.

9.2.2.4.1 Component Cooling Heat Exchangers

Two component cooling heat exchangers are provided for each unit. Unit 1 has one tube and shell-type heat exchanger and one plate-type heat exchanger; Unit 2 has two tube and shell-type heat exchangers. Service water circulates through the cold side while component cooling water circulates through the hot side.

Each component cooling heat exchanger is designed to remove one-half of the heat load occurring at 20 hours after plant

shutdown. Each heat exchanger is also capable of removing one-half of the maximum heat removal load occurring when the RHR System is first placed in operation during a plant cooldown operation. The heat removal load during normal full-power operation is transferred by one component cooling heat exchanger with the additional exchanger providing 100 percent standby capacity.

The provision of two component cooling heat exchangers assures that heat removal capacity is only partially lost if one exchanger fails or becomes inoperative, and allows maintenance or replacement of one exchanger while the other unit is in service.

9.2.2.4.2 Component Cooling Pumps

The three component cooling pumps which circulate component cooling water through the Component Cooling System are horizontal, centrifugal units of standard commercial construction. The pump motors receive electric power from the 4160-V vital buses.

The component cooling flow requirement during full-power operation is normally met by operation of two component cooling pumps; the third pump provides standby capacity. During plant cooldown all three pumps are operated and each pump circulates one-third of the total component cooling flow.

9.2.2.4.3 Component Cooling Surge Tank

The surge tank, in addition to the piping connections, has a flanged opening at the top for additions of chemical corrosion inhibitor to the Component Cooling System. For the purpose of homogenizing this chemical with the rest of the system, a recirculation line from the pump discharge is provided.

Normally the tank is open to the atmosphere, but if high radiation is detected in the Recirculating System the vent line is

automatically closed. The tank is connected to the system by two lines, both equipped with locked-open valves.

The tank has an internal baffle divider to provide two separate surge volumes. This arrangement provides redundancy for a passive failure during recirculation following a LOCA.

9.2.2.4.4 Valves

Since the component cooling water is not normally radioactive, special features to prevent leakage from the valves to the atmosphere are not provided. Self-actuated spring loaded relief valves are provided for lines and components that could be pressurized to their design pressure by improper operation or malfunction.

9.2.2.4.5 Piping

All Component Cooling System piping is carbon steel or substitutable chrome alloy material with welded joints and connections except at components which might require removal for maintenance. The piping is of carbon steel since the coolant contains a corrosion inhibitor.

9.2.2.5 <u>Design Evaluation</u>

9.2.2.5.1 Availability and Reliability

Inside the containment, most of the piping, valves, and instrumentation are located outside the crane wall at an elevation above the water level in the bottom of the containment at post-accident conditions. In this location the portions of the system within the containment are protected against credible missiles and from flooding during post-accident operations. This location also provides radiation shielding which permits maintenance and inspection to be performed during power operation. (The exceptions are the cooling lines for the reactor coolant pumps which are isolated following a postulated LOCA.)

The component cooling pumps, heat exchangers, and associated valves, piping and instrumentation are located outside of the containment and are therefore available for maintenance and inspection during power operation. Replacement of a pump or heat exchanger is practicable while the other components are in service. 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 safeguards equipment.

Power is supplied to each of the component cooling pumps from separate 4160 V buses. These buses are normally supplied from separate diesel generators in the event of loss of offsite power. Upon power failure coincident with a LOCA, the component cooling pumps are manually loaded on the vital buses. During a LOCA not coincident with loss of offsite power, the diesels will start but will not be loaded and power to the component cooling water pumps is not interrupted.

9.2.2.6 Leakage Provisions

To minimize the possibility of leakage from piping, valves, and equipment, welded construction is used wherever possible. The component cooling water could become contaminated with radioactive water due to one of the following conditions:

1. A leak in any heat exchanger tube in the CVCS, Sampling System, RHR System, or Spent Fuel Pool Cooling System or a cooling coil for the thermal barrier cooler on a reactor coolant pump.

2. A leak in the residual heat exchangers following an accident. (Tube or coil leaks in components being cooled are detected by radiation monitors located on the component cooling heat exchanger outlet headers.)

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

The relief valve on the component cooling surge tank is sized to relieve the maximum flow rate of water which enters the surge tank following a rupture of a reactor coolant pump thermal barrier cooling coil. The set pressure is equal to the design pressure of the component cooling surge tank. The discharge of this valve is directed to the waste holdup tank. The relief valve on the plant auxiliaries' header is sized to relieve the volumetric expansion from all components on that header should it be isolated from the surge tank.

9.2.2.7 Incident Control

The portion of the Component Cooling System located inside the containment can be isolated following a LOCA. The lines to and from the excess letdown heat exchanger are isolated in phase A isolation and the lines to and from the reactor coolant pumps in phase B. The cooling water supply line to the reactor coolant pumps contains a check valve inside and remote operated valves outside the containment wall. Each return line from the pumps has remote operated valves inside and outside the containment wall. The cooling water supply line to the excess letdown heat exchanger contains a check valve inside the containment wall and both supply and return lines have valves outside the containment wall which can close automatically to isolate that portion of the system. Except for the normally closed makeup line and equipment vent and drain lines, there are no direct connections between the cooling water and other systems. The equipment vent and drain lines outside the containment have manual valves which are normally

closed unless the equipment is being vented or drained for maintenance or repair operations.

The Component Cooling System instrumentation provides the required signals for safe, reliable, and efficient operation and control of the system. All alarms are located in the Control Room.

9.2.2.8 Reactor Coolant Pump/Motor Cooling

9.2.2.8.1 Description

Component cooling water is provided to the reactor coolant pump thermal barrier heat exchanger, as well as to the upper and lower motor bearing oil coolers. In addition, seal injection flow is supplied to the pumps from the CVCS. These cooling supplies are discussed in the following paragraphs and are shown schematically on Figure 9.2-5.

The thermal barrier is a welded assembly consisting of a flanged cylindrical shell, a series of concentric stainless steel cans, a heat exchanger coil assembly, and three flanged water connections.

Component cooling water enters the thermal barrier through a flanged connection on the thermal barrier flange (See Figure 9.2.6). The cooling water flows through the inside of the coiled stainless steel tubing in the heat exchanger and exits through another flanged connection on the thermal barrier flange.

During normal operation, the thermal barrier limits the heat transfer from the reactor coolant to the pump internals. If a loss of seal injection flow should occur, the heat exchanger in the thermal barrier assembly cools the reactor coolant before it enters the radial bearing and the shaft seal area. Conversely, if a loss of component cooling water to the thermal barrier heat exchanger should occur, the seal injection flow is sufficient to prevent damage to the seals.

The upper bearing assembly contains an oil-cooled pivoted-pad radial guide bearing (upper guide bearing), as well as a double acting oil-cooled Kingsbury-type thrust bearing (see Figure 9.2-7). The thrust bearing shoes are positioned above and below a common runner to accommodate thrust in both directions. The shoes are mounted on equalizing pads, which distribute the thrust load equally to all the shoes.

The oil is circulated through and cooled by component cooling water in an external oil-to-water shell and tube heat exchanger (oil cooler).

The lower guide bearing is a pivoted-pad radial bearing, similar to the upper guide bearing.

The entire lower guide bearing assembly is located in the lower oil reservoir, which contains an integral oil-to-water coil type heat exchanger (See Figure 9.2-7).

As discussed above, component cooling water is provided to the reactor coolant pump thermal barrier heat exchanger, as well as to the upper and lower motor bearing oil coolers. Should a loss of component cooling water to the reactor coolant pumps occur, the CVCS continues to provide seal injection flow to the reactor coolant pumps; the seal injection flow is sufficient to prevent damage to the seal with a loss of thermal barrier cooling. However, the loss of component cooling water to the motor bearing oil coolers will result in an increase in oil temperature and a corresponding rise in motor bearing metal temperature. It has been demonstrated by testing (discussed below) that the reactor coolant pumps will incur no damage as a result of a component cooling water flow interruption of 10 minutes.

Two reactor coolant pump motors have been tested with interrupted component cooling water. These tests were conducted at the Westinghouse Electro Mechanical Division. In both bases, the reactor coolant pumps were operated to achieve "hot" (2230 psia,

552°F) equilibrium conditions. After the bearing temperatures stabilized, the cooling water flow to the upper and lower motor bearing oil coolers was terminated and bearing (upper thrust, lower thrust, upper guide and lower guide) temperatures were monitored. A bearing metal temperature of 185°F was established as the maximum test temperature. When that temperature was reached, the cooling water flow was restored.

In both tests, the upper thrust bearing exhibited the limiting temperatures. Figure 9.2-8 shows the upper thrust bearing temperature versus time. In both cases, 185°F was reached in approximately 10 minutes.

The reactor coolant pump bearing temperature alarm is set at 175 degrees Fahrenheit. The operator will immediately execute the trip procedure upon receipt of this alarm.

The maximum test temperature of 185°F is also the suggested alarm setpoint temperature, and the suggested trip temperature is 195°F. It should be noted that the melting point of the babbitt bearing metal exceeds 400°F. The information presented above constitutes the basis of the RCP qualification for 10-minute operation without component cooling water with no resultant damage.

9.2.2.8.2 Operating Procedures

Public Service Electric & Gas (PSE&G) Operating Procedures for Salem Units 1 and 2 have been revised to address the loss of component cooling water to the reactor coolant pumps in sufficient detail to cover the concerns expressed. Upon a valid low component cooling flow alarm to a single reactor coolant pump, the operator will trip the reactor coolant pump within 5 minutes if flow cannot be restored to the reactor coolant pump. Upon a valid low component cooling flow alarm to more than one reactor coolant pump, the operator will trip the reactor and affected RC pumps within 5 minutes if flow cannot be restored to the RCPs. This action will be performed prior to the motor bearing reaching its design operating temperature.

9.2.2.8.3 Analysis of Simultaneous Multiple Pump Seizure Probability

As discussed above, a loss of component cooling water to the motor bearing oil coolers will result in an increase in oil temperature

and a corresponding rise in motor bearing temperature. Westinghouse contends that the loss of component cooling water to the reactor coolant pumps will not result in an instantaneous seizure of two pumps simultaneously and is not a credible ultimate consequence.

Instead, it is Westinghouse's technical opinion that a more realistic ultimate consequence will be an abbreviated coastdown. If a limiting condition of the babbitt metal is considered, an increasing coefficient of friction as well as an increasing retarding torque is expected. However, in view of the large rotational inertia of the pump/motor assembly, Westinghouse maintains that an instantaneous seizure will not result.

Because an initial seizure is not expected, it is not possible to define a precise point in time at which a sequential seizure would be anticipated. Therefore, for the purpose of defining the time expected between sequential seizures, the following discussion is presented in terms of sequential occurrences of reaching a "high" bearing temperature. As discussed above, the upper thrust bearing exhibits the limiting temperature. Therefore, an upper thrust bearing temperature of 240°F has been chosen arbitrarily as the "high" temperature. It should be noted that the use of this value does not imply pump seizure at this temperature.

Variables affecting the steady state operating temperature of the bearings include the following:

1. Surface finish of the bearing and runner

2. Bearing (and oil pumping mechanism) clearances

3. Inlet temperature of water to heat exchanger (oil cooler)

4. Condition of oil-to-water heat exchanger (oil cooler), i.e., extent of fouling

5. Condition of oil

6. Amount of oil in oil pot

7. Oil temperature

These variables would be expected to interact concurrently in a manner which individualizes the performance of the bearings during actual steady state plant operation. In order to quantify the resultant variation in performance, Westinghouse has collected data from an operating four-loop plant. This data demonstrates that the upper thrust bearings operate at different steady state temperatures (i.e., 128°F, 132°F, 135°F, and 145°F).

Using these actual steady state operating values (A=128°F, B=132°F, C=135°F, D=145°F) and assuming a conservative 5°F/minute linear heatup rate after a loss of component cooling water sequential occurrences of reaching the "high" bearing temperature could be expected at the time intervals tabulated below: (See Figures 9.2-9 and 9.2-10)

Sequential Motors	Operating Temperature (°F)	Time Interval (minutes)
A and B	4	0.85
B and C	3	0.65
C and D	10	2.875
A and C	7	1.5
B and D	13	2.525
A and D	17	3.375

To summarize, two bearings sequentially reaching a temperature of 240°F could be expected at a minimum time interval of 0.65 minute and at a maximum time interval of 3.375 minutes.

Westinghouse has obtained motor bearing heatup data, as discussed previously. These test data show actual values of bearing

temperatures following a loss of component cooling water. The test data presented on Figure 9.2-8 will be examined relative to the above discussion. The test runs, which were performed at different times using different motors, demonstrate similar heatup rates. This fact supports the assumption of identical linear heatup rates made in the previous discussion. In addition, the average heatup rates evidenced in the test data are less than 3.3°F per minute, which substantiates the use of 5°F per minute as a conservative value. The actual test data, although limited, is supportive of the assumptions posed in defining the time intervals tabulated above.

In conclusion, Westinghouse contends that a single or multiple pump seizure as the result of a loss of component cooling water to the reactor coolant pumps is not a credible event. However, in our judgment and based on the above discussion, two reactor coolant pump motor upper thrust bearings could sequentially reach a "high" bearing temperature of 240°F at a minimum time interval of 0.65 minute (or approximately 40 seconds).

9.2.2.8.4 Definition of Core Damage and Pressure Transients as a Result of Two Sequential Locked Rotors

Section 15 presents the analysis of a single reactor coolant pump locked rotor. It should be pointed out that the analysis assumes an instantaneous seizure of a reactor coolant pump rotor on a non-mechanistic basis.

As discussed above, Westinghouse contends that a postulated mechanistic instantaneous seizure of a pump rotor due to loss of component cooling water to the reactor coolant pump will not occur and is not a credible event.

However, in response to the Nuclear Regulatory Commission's request, the results of a second non-mechanistic instantaneous seizure occurring at 40 seconds (defined previously) after a first non-mechanistic instantaneous seizure have been evaluated.

Although a Final Safety Analysis Report approach was utilized to evaluate this situation, Westinghouse does not recognize a postulated mechanistic instantaneous locked rotor as a credible consequence of the loss of component cooling water to the reactor coolant pumps.

Assuming that a second pump seizure occurs 40 seconds after a first pump seizure, no noticeable change is seen in the RCS pressure and the clad temperature transients. Furthermore, even if the time interval between the sequential seizures is reduced to 10 seconds, no noticeable change is seen in the RCS pressure and the clad temperature transients.

The hypothetical seizure of one reactor coolant pump results in a low flow reactor trip approximately 1 second after the initial of the event. As a result of the fast reactor trip and the consequential decrease in core heat flux, the reactor coolant system pressure and the clad temperature reach the peak values at about 2.5 seconds and then start to decrease.

Because the core has been shut down, at 40 seconds, or even 10 seconds, after a pump seizure, the RCS pressure and the clad temperature transients have decreased to a point at which a second pump seizure results in no noticeable change in the transients.

9.2.2.8.5 Single Failure Criteria Related to Electrical Power Requirements

An audit of the electrical design involved in the redundant supplies of cooling water to the reactor coolant pump seals has been performed to verify the ability of control and motive power sources to meet the single failure criterion.

The result of this audit shows that there are no credible single electrical failures capable of causing a total loss of cooling water to any reactor coolant pump. The equipment and controls

analyzed are the following (Unit 1 numbers are used. Unit 2 analysis is identical).

CVCS

Isolation valves ICV116 and ICV284 RCP
Seal Leakoff valves CV104 (11-14)

Component Cooling

Cooling water supply valves ICC117 and IC118
Bearing water return valves ICC136 and ICC187
Thermal barrier water return valves ICC131 and ICC190

All the valves identified except the CV104 valves are 230 V ac motor-operated valves. The CV104 valves are 125 V dc solenoid- operated valves.

The CV104 valves have been designed to fail into the open position upon loss of control power or air. Each valve control circuit has been assigned to a separate control grouping which insures physical separation of all involved control devices. All credible failures result in an open valve. An individual valve "hot-short" could potentially cause a loss of seal water flow to only one pump. Such a failure could not cause the coincident loss of component cooling flow.

The motor-operated valves perform the safety function of containment isolation, and are separated among the three vital 230 V ac buses. All of these valves are normally open and remain open unless signaled to close by containment isolation logic. One-half of the component cooling valves would close upon receipt of a containment isolation signal (phase B) from protection Train A. The other half would close upon the same signal from Train B. The CVCS would be closed upon receipt of containment isolation (phase A) signals from their respective protection trains. There are no credible failures capable of causing both of

these events to coincide. A design basis LOCA would result in closure of all valves to comply with containment isolation criteria.

All motive power and control circuits have been analyzed for potential failures. The results of this analysis indicate that no credible failure mechanism can cause loss of all cooling flow to the reactor coolant pumps.

9.2.2.9 Malfunction Analysis

The malfunction analysis of pumps, heat exchangers, and valves is presented in Table 9.2-5.

9.2.2.10 Tests and Inspections

Active components of the Component Cooling System are either in continuous or intermittent use during normal plant operation. Surveillance requirements for inservice inspection and testing of components are in accordance with the Technical Specifications.

9.2.3 Demineralized Water Makeup System

Makeup water required for the high purity water systems in the station can be produced from demineralizers. Water from wells on the station property is used as makeup to the Demineralizer System. Two 500,000-gallon outdoor demineralized water storage tanks are provided. The demineralized water storage tanks are shown on Plant Drawings 205213 and 205246.

9.2.4 Potable Water Systems

The Potable Water Systems use a combination of deep groundwater (subsurface) wells as the supply source in sufficient capacity for all of the plant requirements which include potable, process makeup, fire protection, and sanitary uses.

Three fresh water wells, located in the Mt. Laurel-Wenonah formation (approximately 300 feet deep) and one fresh water well, located in the upper Raritan formation (approximately 800 feet deep) supply through well pumps a total of 1000 gpm of fresh water to two 350,000 gallons of water which are reserved for fire protection use, or the Auxiliary Feedwater System and the upper 50,000 gallons (hereafter referred to as "plant" water) are used for potable, sanitary, and process makeup purposes. The station water is pumped from the storage tanks to the station's process water equipment through an 8-inch main, and to all sanitary and potable water equipment through a 4-inch main by a constant pressure pumping system consisting of three automatically-operated pumps and one standby pump which maintain a constant 70 psig discharge pressure.

If, for some reason, the Fresh Water Systems fail to operate, it will not affect any safety-related equipment on a short-term basis as each of the safety-related systems store sufficient quantities of water to enable that system to perform its functions.

The following design criteria prevent any radioactivity source in the plant from contaminating the Potable Water System:

1. Each fresh water supply well is approximately 300 feet deep (or more) and has two impervious clay formations between the ground surface and the source of water supply. Also, the wells are double-cased and cement-grouted from the bottom of the gravel pack to grade which prevents seepage of surface waters. The

source of water is thereby protected from any outside contamination.

2. The Fresh Water System does not enter any radioactive area nor does it supply any radioactive equipment, directly or indirectly.

3. The water supplies to potentially radioactive areas, such as the "hot" machine shop and the monitoring area, and the demineralizers, are protected from contamination by the use of backflow preventers, of the type approved by the New Jersey Department of Health, on all such pipelines.

4. The water storage tanks are enclosed and are 250 feet from any potential radioactive building.

TABLE 9.2-1

SERVICE WATER SYSTEM FLOWS AND HEAT LOADS (PER UNIT)(7)

			Mode of Operation			
	Start-up	Normal	Normal Shutdown	Blackout No Accident	Injection Phase	Recirculation Phase
No. of pumps required	4	4	3	2(4)	2(4)	3(6)
Flow required for services, gpm						
Service Water Intake	1,230	1,230	1,115	1,000	1,000	1,115
Turbine Services	15,184	26,084	3,737	0	0	0
Nuclear Services	23,730(1)	14,200	23,782	12,453	10,137(2)	31,027(2)
Total Flow (5)	40,144	41,514	28,634	13,453	11,137	32,142
Estimated Heat Loads, Btu/hr x 10^6						
Turbine Services	67.24	114.14	17.00	0	0	0
Nuclear Services	77.45	78.74	325.27(3)	39.44	271.9	536.82
Total Estimated Heat Load	144.69	192.88	342.27	39.44	271.9	536.82

Notes:

(1) Remove one of two component cooling heat exchangers from service prior to feeding service water to second Turbine Auxiliaries Cooling System heat exchanger.

(2) Westinghouse transmittal PSE-94-568 defines a minimum flow of 8,000 gpm at 90°F for one CCHX in service.

(3) First four hours following shutdown.

(4) Assume only two diesel generators running.

(5) At service water temperature of 90°F.

(6) LOCA + LOOP - Maximum Safeguards Condition

(7) The flows listed in this table are based upon the design flows associated with the equipment and components required for various plant operating modes. The actual flows available for these plant operating modes may vary from the above flows and are documented in the Service Water System calculations.

TABLE 9.2-2

COMPONENT COOLING SYSTEM CODE REQUIREMENTS

Component Cooling Heat Exchangers (Shell/Tube Type)	ASME Sect VIII
Component Cooling Heat Exchangers (Plate Type)	ASME Sect III Class 3
Component Cooling Surge Tank	ASME Sect VIII
Component Cooling Loop Piping	ANSI B31.1.0([1])
Component Cooling Valves	ANSI B31.7([2])

([1])Used for design

([2])For piping not supplied by the NSSS supplier, material inspection, fabrication, and quality control conform to ANSI B31.7. Where not possible to comply with ANSI B31.7, the requirements of ASME III-1971, which incorporated ANSI B31.7, were adhered to.

TABLE 9.2-3

COMPONENT COOLING SYSTEM
FLOW REQUIREMENTS - ONE UNIT

(gpm)

	Normal	Loss of Coolant Accident (Recirculation Phase) (1)
Residual heat exchangers	-	4,000
Reactor coolant pumps	760 (min)	-
Seal water heat exchanger	210	-
Sample heat exchangers (both units)	308 (max)	-
Letdown heat exchanger	1,000 (4)	-
Spent fuel pool heat exchanger	3,000 (4)	-
Residual heat removal pumps	20	10
Safety injection pumps	20	10
Charging pump (Reciprocating)	100 (7)	100 (2)(7)
Charging pumps (Centrifugal)	28 (max)(9)	14 (max)(9)
Waste evap package	780 (5)	-
Boric acid evap package	1,896 (5)	-
Waste gas compressors	85 (6)	-
Excess letdown heat exchanger	230 (5)	-
TOTAL	8,437	4,134 (3)
Number of pumps required	2	1
Number of pumps in service	2	1
Number of pumps installed	3	

Pump capacity (ea) - 4,600 gpm(8)
Pump head - 200 ft TDH(8)

(1) The data is for each component cooling loop
(2) This load is only for loop B
(3) Loop A total is 4034 gpm and for loop B total is 4134 gmp
(4) Varies with heat load
(5) May be out of service
(6) Maximum flow for two waste gas compressors heat exchangers. Components in service may vary with load.
(7) Varies with CCW temperature and/or CC heat load. May be throttled.
(8) Design Point. Not maximum value.
(9) Component Cooling Flow to 21 and 22 Centrifugal Charging Pumps eliminated.

TABLE 9.2-4

COMPONENT COOLING SYSTEM
COMPONENT DESIGN DATA

<u>Component Cooling Pumps</u>

Quantity	3
Type	Horizontal Centrifugal
Rated capacity, gpm (Design Point)	4600
Rated head, ft H_2O (Design Point)	200
Design pressure, psig	150
Design temperature, °F	200
Available NPSH, ft	25
Material[(1)]	Carbon steel

<u>Component Cooling Heat Exchangers (Shell and Tube Type)</u>

	Shell	Tube
Number		2
Design heat transfer, Btu/hr		44.2×10^6
Design pressure, psig	150	180
Design temperature, °F	200	200
Design flow rate, lb/hr	3.41×10^6	4.99×10^6 [(1)]
Design inlet temperature, °F	113.0	90
Design outlet temperature, °F	100.0	99.3
Fouling Factor, hr-ft^2-°F/BTU	0.0005	0.00091 (11 & 21 CCHXs) 0.00097 (22 CCHX)
Fluid	Component cooling water	Service Water
Material	Carbon steel	Titanium

Component Cooling Heat Exchanger (Plate Type)

Number	1[2]
Design heat transfer, Btu/hr	44.2×10^6
Fouling factor (total), hr-ft^2-°F/BTU	0.001

	Component Cooling Water Side	Service Water Side
Design pressure, psig	150	180
Design temperature, °F	200	200
Design flow rate, lb/hr	3.41×10^6	4.99×10^6[1]
Design inlet temperature, °F	113.0	90.0
Design outlet temperature, °F	100.0	99.3
Material	Titanium	Titanium

Component Cooling Surge Tank

Number	1
Type	Horizontal, with divider plate
Design pressure: Internal, psig	100
External, psig	Vacuum breaker provided
Design temperature, °F	200
Normal operating pressure, psig	Atmospheric
Total volume, gal	2000
Normal water volume, gal	1000
Fluid	Component cooling water
Material	Carbon Steel

(1) Westinghouse transmittal PSE-94-568 defines a minimum flow of 8000 gpm (4.00×10^6 lbs/hr) for accident conditions.

(2) Unit 1 has one shell and tube-type and one plate-type heat exchanger. Unit 2 has two shell and tube-type heat exchangers.

TABLE 9.2-5

COMPONENT COOLING SYSTEM - MALFUNCTION ANALYSIS

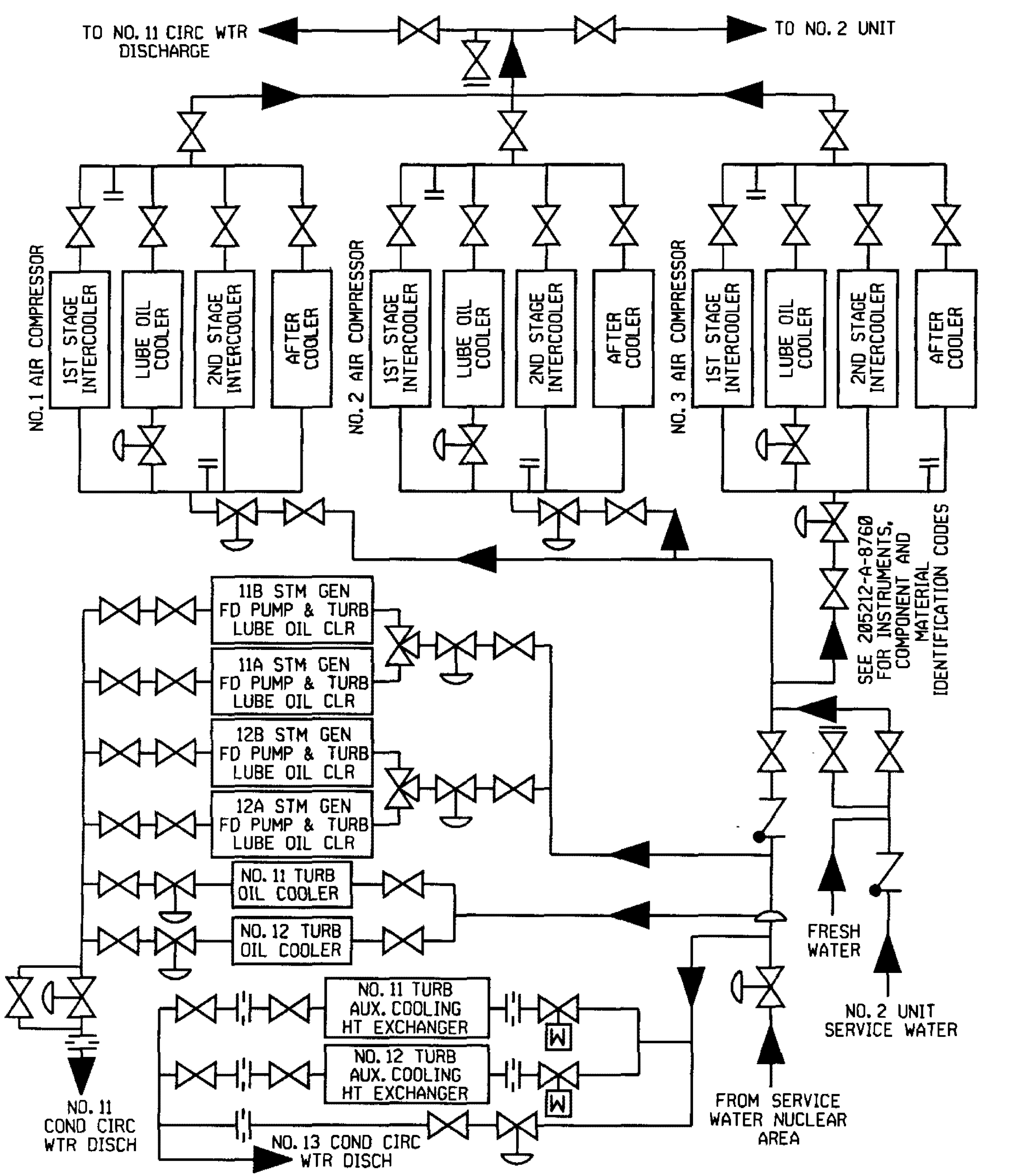
	Component	Malfunction	Comments and Consequences
1.	Component cooling water pumps	Rupture of pump casing	The casing and shell are designed for 150 psi and 200°F which exceeds maximum operating conditions. Pump is inspectable and protected against credible missiles. Rupture is not considered credible.
2.	Component cooling water pumps	Pump fails to start	One operating pump will supply sufficient flow. Redundancy is sufficient to provide ample flow for any condition.
3.	Component cooling water pumps	Manual valve on a pump suction line closed	This will be prevented by prestartup and operational checks. Further, during normal operation, each pump will be checked on a periodic basis which would show that a valve was closed.
4.	Component cooling water pump	Stop valve on discharge line closed or check valve sticks closed	Stop valve will be checked open by prestartup and operational checks. The stop valve and the check valve will be checked by periodic operation of the pumps during normal operation.
5.	Component cooling heat exchanger	Tube or shell rupture	Rupture is considered incredible because of low operating pressures.
6.	Component cooling heat exchanger vent or drain valve	Left open	This will be prevented by prestartup and operational checks. During normal operation such a situation would be readily assessed by observation of level in the component cooling surge tank.

Figure F9.2-1A Sheets 1 through 7 OF 7 intentionally deleted.

Refer to plant drawing 205242 in DCRMS

Figure F9.2-1B Sheets 1 through 6 of 6 intentionally deleted.

Refer to plant drawing 205342 in DCRMS



Revision 19, Nov. 19, 2001

PSEG Nuclear, LLC SALEM NUCLEAR GENERATING STATION	Salem Nuclear Generating Station SERVICE WATER SYSTEM-TURBINE AREA UNIT 1
	Updated FSAR Figure 9.2-2A

Figure F9.2-2B intentionally deleted.

Refer to plant drawing 205312 in DCRMS

Figure F9.2-3 intentionally deleted.

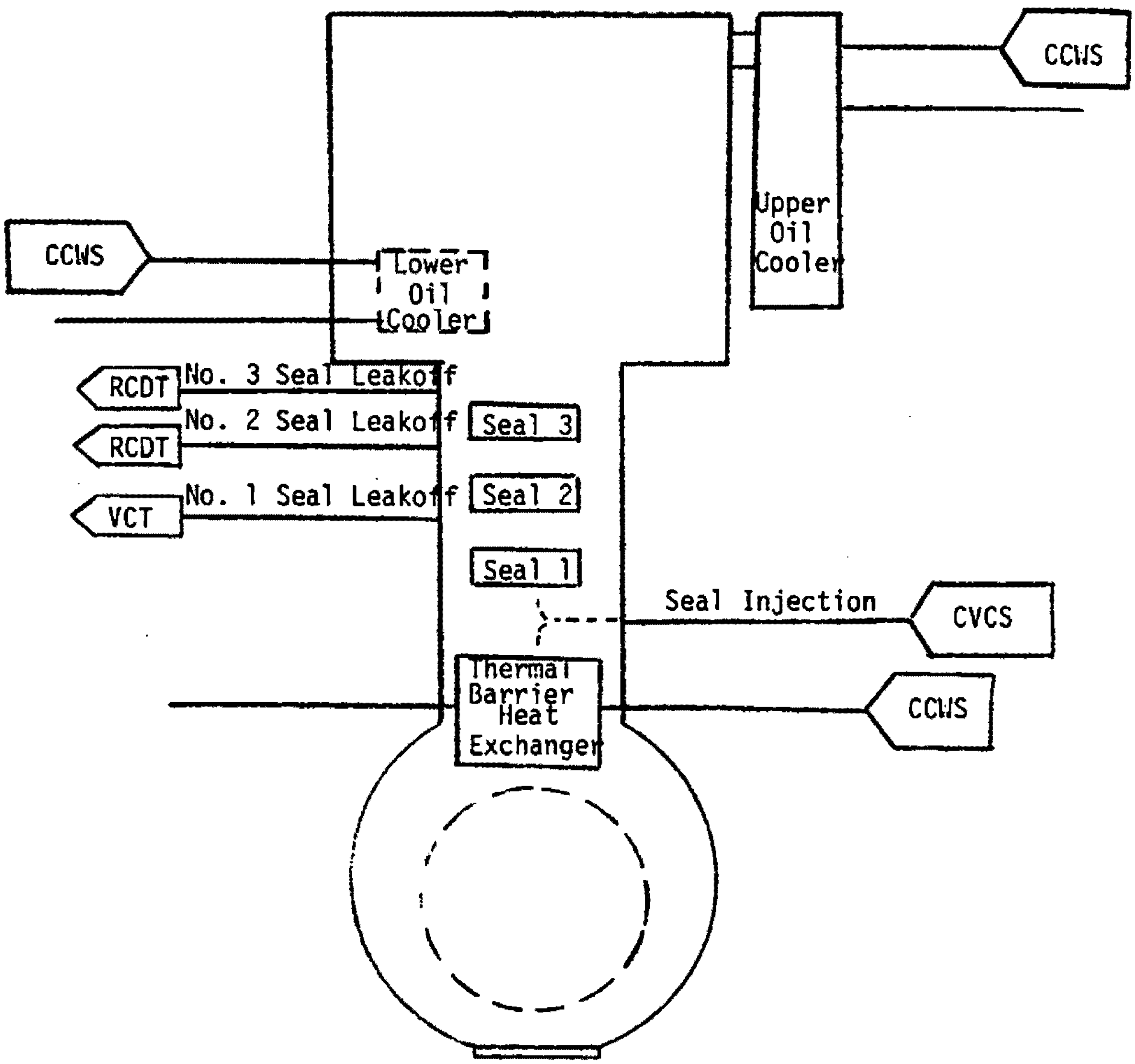
Refer to plant drawing 211612 in DCRMS

Figure F9.2-4A Sheets 1, 2 & 3 of 3 intentionally deleted.

Refer to plant drawing 205231 in DCRMS

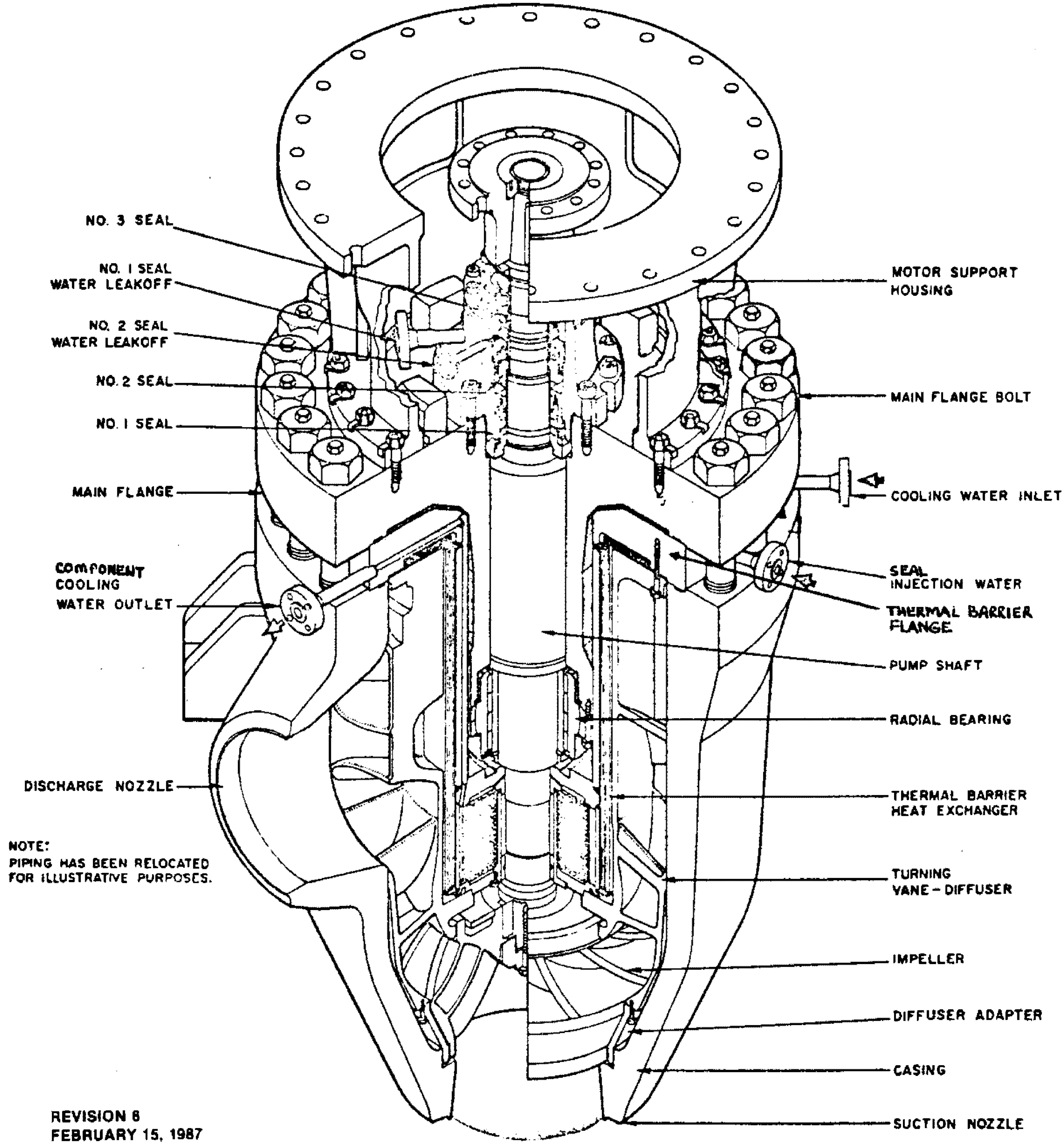
Figure F9.2-4B Sheets 1, 2 & 3 of 3 intentionally deleted.

Refer to plant drawing 205331 in DCRMS



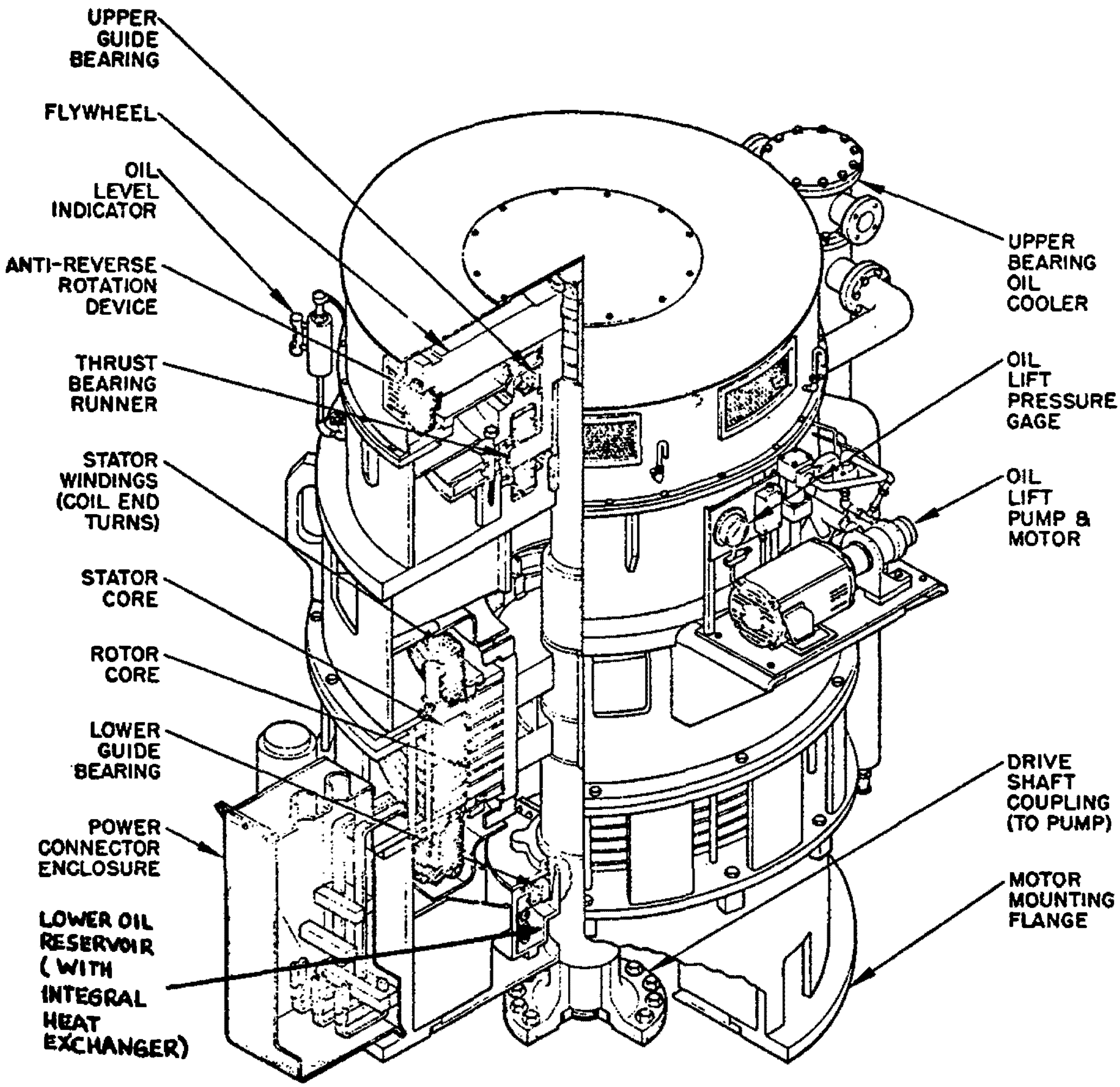
REVISION 6
FEBRUARY 15, 1987

PUBLIC SERVICE ELECTRIC AND GAS COMPANY SALEM NUCLEAR GENERATING STATION	RCP Cooling Supplies	
	Updated FSAR	Figure 9.2-5



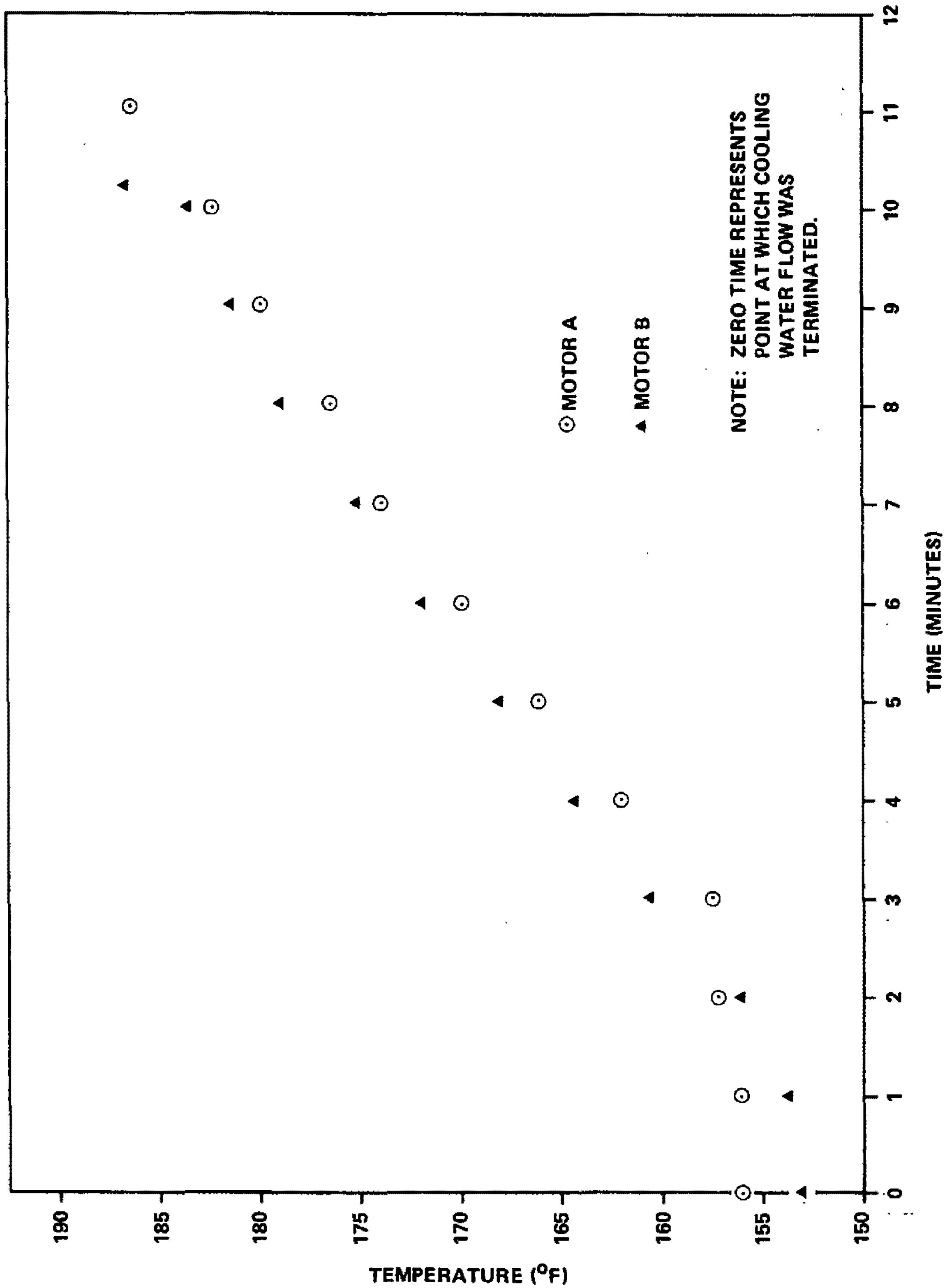
REVISION 6
FEBRUARY 15, 1987

PUBLIC SERVICE ELECTRIC AND GAS COMPANY SALEM NUCLEAR GENERATING STATION	Reactor Coolant Pump
	Updated FSAR — Figure 9.2-6



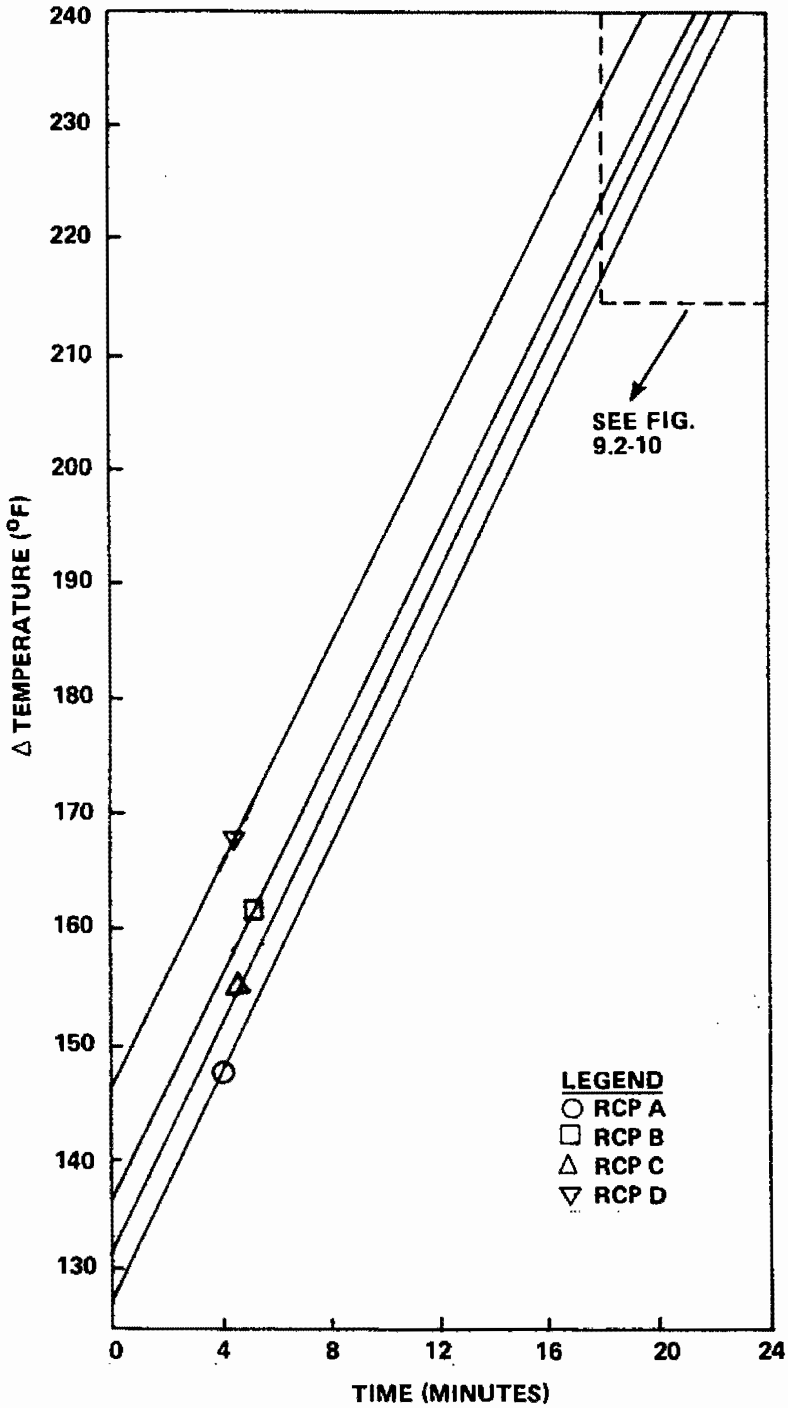
REVISION 6
FEBRUARY 15, 1987

PUBLIC SERVICE ELECTRIC AND GAS COMPANY SALEM NUCLEAR GENERATING STATION	Reactor Coolant Pump Motor
	Updated FSAR — Figure 9.2-7



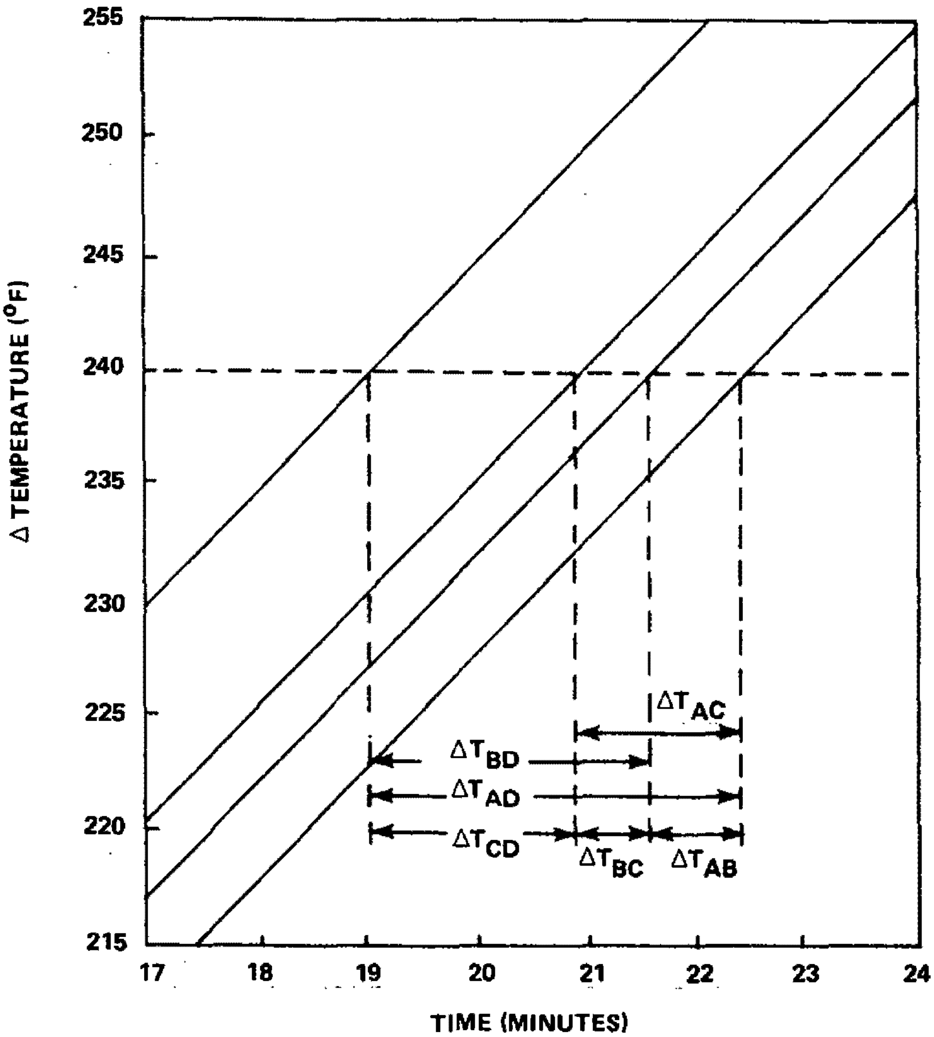
REVISION 6
FEBRUARY 15, 1987

PUBLIC SERVICE ELECTRIC AND GAS COMPANY SALEM NUCLEAR GENERATING STATION	Motor Upper Thrust Bearing Temperatures After Termination of CCW Flow	
	Updated FSAR	Figure 9.2-8



REVISION 6
FEBRUARY 15, 1987

PUBLIC SERVICE ELECTRIC AND GAS COMPANY SALEM NUCLEAR GENERATING STATION	Reactor Coolant Pump Temperature Time Transients	
	Updated FSAR	Figure 9.2-9



REVISION 6
FEBRUARY 15, 1987

PUBLIC SERVICE ELECTRIC AND GAS COMPANY SALEM NUCLEAR GENERATING STATION	Reactor Coolant Pump Temperature Time Transients	
	Updated FSAR	Figure 9.2-10

THIS FIGURE HAS BEEN DELETED.

PUBLIC SERVICE AND GAS COMPANY SALEM NUCLEAR GENERATING STATION

THIS FIGURE HAS BEEN DELETED.

THIS FIGURE HAS BEEN DELETED.

PUBLIC SERVICE AND GAS COMPANY SALEM NUCLEAR GENERATING STATION

Updated FSAR
Revision 15 June 12, 1996

Figure 9.2-11
Sheet 3 of 7

THIS FIGURE HAS BEEN DELETED.

PUBLIC SERVICE AND GAS COMPANY SALEM NUCLEAR GENERATING STATION

Updated FSAR
Revision 15

June 12, 1996

Figure 9.2-11
Sheet 4 of 7

Figure F9.2-11 Sheet 5 of 7 intentionally deleted.

Refer to plant drawing 205213 in DCRMS

Figure F9.2-11 Sheets 6 & 7 of 7 intentionally deleted.

Refer to plant drawing 205246 in DCRMS

9.3 PROCESS AUXILIARIES

9.3.1 Compressed Air System

The Compressed Air System provides the station with a reliable supply of clean, oil free air which is directed to various locations for services as required. The system is illustrated on Plant Drawings 205217 and 205317.

9.3.1.1 Design Bases

The system provides a reliable supply of clean, oil free, dry air at temperatures and pressures suitable for use as control air and for containment penetration cooling, as well as for miscellaneous services and maintenance.

The Compressed Air System is designed such that any single failure will not result in loss of function.

9.3.1.2 System Description

9.3.1.2.1 General

The Compressed Air System is supplied by three motor-driven, oil free, centrifugal compressors which draw air from the atmosphere. The intakes of the air compressors are located to avoid drawing in toxic or corrosive gases. Each compressor has a capacity of 3300 scfm at 120 psig discharge pressure. One compressor is typically running to satisfy the normal requirements of station air and control air for both units as well as to supply containment penetration cooling air for both units. A second compressor serves as standby. A third compressor is available when required. Each compressor is furnished with a 800-hp motor, intake filter-silencer, blow-off silencer and digital pressure controls only, intercoolers, aftercooler, and moisture separator. The compressors discharge into two independent service air headers, with an air receiver tied to each header.

The station air header for each unit is supplied from either of the two service air headers. This station air header provides operating and service requirements at various locations.

The containment penetration cooling system for each unit is furnished with two supply lines. The normal supply is taken from the station air header and the backup supply from either of the two service air headers.

9.3.1.2.2 Control Air

The Control Air System for each unit consists of a dual header arrangement as shown on Plant Drawings 205247 and 205347. This control air for each unit is supplied through two distinct parallel paths. One path is supplied from the Unit 1 Station Air System and the other is supplied from the Unit 2 Station Air System. Control air for the safety-related portions is automatically backed up by an emergency control air compressor. Control air is fed from the Station Air System through heatless, desiccant-type air dryers.

The dual station service air headers are fed by three 100-percent capacity air compressors, any one of which can supply the total service and control air requirements for both units.

In addition to the normal air supply from the service air headers, each system has an emergency control air compressor complete with its own dryer and accessories to supply the safety-related headers. The emergency control air for either system may be directed to supply air for the opposite system through a valved connection. Each emergency control air compressor motor is energized from the standby ac power supply. The Emergency Control Air System is designated Class I (seismic) and is located in a Class I (seismic) structure.

Each emergency control air compressor has a capacity of 500 scfm at 110 psig and is driven by a 125-hp motor. Accessory equipment includes an independent heatless desiccant-type air dryer, intake filter, silencer, intercooler, aftercooler, moisture separator, inlet control valve, relief valve and automatic condensate trap and drain. The emergency control air compressors with Teflon piston rings and stainless steel cylinder liners. Cooling of the emergency control air compressors is provided from the safety-related Chilled Water System. In the event that the Chilled Water System is not available, the Service Water System (SWS) serves as a backup.

Operational or test data that verify the functional reliability of the emergency control air compressors were not initially available although stress analysis calculations by the manufacturer indicated that the compressor could withstand both operational and seismic loadings simultaneously.

The parallel control air headers for each unit include air receivers of sufficient capacity to dampen pressure surges and act as a momentary reservoir of air to permit switching of air supply sources without cycling the system.

The Compressed Air System is also backed up by the Station Blackout (SBO) emergency diesel driven air compressor through a connection to Header 2A as illustrated in Plant Drawing 604495. This SBO air compressor is designed to be manually started in the event of a loss of offsite power coincident with the failure of either the "C" emergency diesel generator or the emergency air compressor in the non-blacked out unit. The SBO Air Compressor may also be used to supply limited control air in the event of a complete loss of control air due to reasons other than a SBO event.

The SBO air compressor, located in the Station Blackout Compressor Building, draws in outside air through louvers built into the building wall. The supply air passes through a filter and then through a regulating inlet valve. After the air has been compressed, it passes through an air/oil separator where the oil is removed and reused for compressor lubrication. The air is then passed through an aftercooler where it is cooled. The excess water is removed by a centrifugal separator and a moisture trap at the aftercooler outlet. A coalescing filter is used to meet the hydrocarbon content requirements by removing oil droplets and particulates to well within the required limits.

The air is passed through a heatless desiccant air dryer to lower the moisture content of the compressed air. An additional filter is added onto the outlet of the air dryer to remove any desiccant fines that may be entrained when passing through the dryer. The compressed air is supplied to the emergency control air header via yard access valve 2CA584 which provides air to all required safety related controls.

9.3.1.3 Design Evaluation

Reserve air storage of sufficient capacity to minimize pressure fluctuation is provided by means of air receivers in each control air header.

The Control Air System is designed to supply the required air during normal and abnormal conditions. Any single component failure will not result in a loss of function. A total loss of control air to all systems and equipment is therefore not considered credible.

Redundant safety-related air users are provided with independent single air supplies from the control air header system. The redundant system instruments have control air supplied from independent air headers.

Separate and redundant headers, backed up by emergency control air compressors energized from the Standby Power System and preservation of header independence, assure that air is available during normal as well as abnormal plant conditions. A single failure within the system would not result in total loss of air supply to redundant equipment. The following are failures considered and the resultant action:

Failure	Action
Loss of a station air compressor	The spare air compressor automatically supplies the total requirements for both units.
Loss of all station air compressors	Each emergency control air compressor, energized from its standby ac power supply, will supply all control air requirements for its safety related headers.
Loss of offsite power and emergency compressor fails to start	Emergency air receivers on each control air header supply enough capacity to maintain header pressure. The second emergency second emergency air compressor can provide the safety-related control air requirements for both units.

The SBO Emergency Compressed Air System is physically isolated and independent of the plant safety related components and system. As a result, during normal and abnormal plant operation or during accident conditions, the systems, structures, and components required to mitigate the consequences of all analyzed events will remain unaffected due to failures of this system. The SBO Emergency Compressed Air System is manually started within one hour following a SBO event. If any abnormality occurs in the starting of the system during an event, appropriate measures will be taken to start the system with replacement spare parts available in stock. Therefore, redundancy and diversity in the system are neither required, nor provided. The SBO Air Compressor may also be used to supply limited control air in the event of a complete loss of control air due to reasons other than a SBO event.

9.3.1.4 Tests and Inspections

Prior to plant operation, the Compressed Air System was inspected and tested to verify correct installation and operation. During plant operation, the system is in operation on a continuous basis, except for the emergency control air compressors which can be tested to verify automatic starting and operability. The maintenance and surveillance on the SBO emergency diesel driven air compressor unit will be performed in accordance with the manufacturer's recommendations.

9.3.1.5 Instrumentation and Control

9.3.1.5.1 Station Air Compressors

The compressor control circuits are designed to protect the compressor against the following hazards:

1. Low oil pressure

2. High air temperature

3. Low/High oil temperature

4. Low cooling water pressure

5. Excessive vibration

9.3.1.5.2 Control Air

The emergency control air compressors may be operated in three modes:

1. Remote manual operation from the Control Room

2. Local manual operation from the "Hot Shutdown panel or

3. Automatic start-stop operation

Normally, the emergency air compressors are in the automatic mode. The compressor motors are started by either tripping of all three station air compressors or decay of control air header pressure below 85 psig, as sensed by a pressure switch in the respective control air header.

The SBO air compressor is designed to be manually started in the event of a loss of offsite power coincident with the failure of either the "C" emergency diesel generator or the emergency air compressor in the non-blacked out unit. The SBO Air Compressor may also be used to supply limited control air in the event of a complete loss of control air due to reasons other than a SBO event. The compressor will trip automatically if any of the operating parameters (engine oil pressure, discharge air temperature, and engine water temperature) exceed their design limits.

9.3.2 Sampling System

9.3.2.1 Design Bases

The Sampling System provides a means for obtaining fluid and gas samples for laboratory analysis of chemistry and radiochemistry conditions of the Reactor Coolant System (RCS) and other systems. The system is designed to permit the taking of samples during reactor operations, during cooldown, and following an accident without requiring access to the containment. The system has no emergency function, nor is it required to take action to prevent an emergency condition. In the event of a loss-of-coolant accident (LOCA), the system is isolated at the containment boundary. Sampling following a LOCA would occur when conditions would allow use of the sample lines.

Sampling system discharge flows are limited under normal and anticipated fault conditions (malfunctions or failure) to preclude any fission product release beyond the 10CFR20 limit. Adequate safety features are provided to protect laboratory personnel and prevent the spread of contamination from the Sampling Room when samples are being drawn. Each unit has an identical sampling system and only the boron analyzer is shared between units. The description contained herein is equally applicable to either unit.

System component code requirements are given in Table 9.3-1.

9.3.2.2 System Description

9.3.2.2.1 General

The Sampling System, shown on Plant Drawings 205244 and 205344, provides the representative samples for laboratory analysis. Analysis results provide guidance in the operation of the RCS, Residual Heat Removal (RHR), Component Cooling, Chemical and Volume Control (CVCS), Main Steam, and Steam Generator Blowdown (SGB) Systems. Analysis shows both chemical and radiochemical conditions. Typical information obtained includes reactor coolant boron and chloride concentrations, fission product radioactivity level,

hydrogen, oxygen, and fission gas content, conductivity, pH, corrosion product concentration, and chemical additive concentration. The information is used in regulating boron concentration adjustments, evaluating fuel element integrity and mixed bed demineralizer performance, and regulating additions of corrosion controlling chemicals to the systems. The Sampling System is designed to be operated manually, on an intermittent basis, except for Steam Generator Blowdown which is continuously analyzed. Samples can be withdrawn under conditions ranging from full power to cold shutdown.

Samples are drawn from the following locations.

Inside Containment

1. The pressurizer steam space
2. The pressurizer liquid space
3. Hot legs of reactor coolant loops 1 and 3
4. The Safety Injection System (SIS) accumulators
5. Steam generator blowdown

Outside Containment

1. The mixed bed demineralizer inlet header
2. The mixed bed demineralizer outlet header
3. Each RHR System heat exchanger outlet
4. The volume control tank gas space
5. Main Steam

Local sample connections are provided at various locations outside the containment. These connections are shown on the respective flow diagrams and are not considered part of the Sampling System.

Samples originating from locations within the containment flow through lines to the Sampling Room in the Auxiliary Building. Each line is equipped with a manual isolation valve close to the source; a remote, air-operated valve immediately downstream of the isolation valve; containment boundary isolation/trip valves located inside and outside the containment, except for blowdown sample lines which have an isolation/ trip valve outside the containment only. Manual valves are located inside the Sampling Room for component isolation, sample flow control and routing. High temperature sample lines also contain a sample heat exchanger.

In addition, the high pressure reactor coolant sample line contains sufficient length to provide at least a 60-second sample transit time within the containment. An additional 20-second transit time from the reactor containment to the sampling hood is provided by the sampling line. This allows for decay of the short-lived isotope, N-16, to a level that permits normal access to the Sampling Room.

All sample lines, whether originating from locations outside the containment or inside, are provided with manual isolation valves. The RHRS also has a remote, air-operated sampling valve.

Samples are drawn in an enclosed room with controlled ventilation and drainage to confine the spillage of radioactivity. The sample flows are limited to preclude the release of radioactivity above 10CFR20 limits in the event of a system failure.

9.3.2.2.2 Operation

Sampling System equipment is located inside the Auxiliary Building with most of it in the Sampling Room. All sample lines from inside the containment have remotely operable valves.

Reactor coolant loop liquid, pressurizer liquid, pressurizer steam and steam generator blowdown samples originate inside the containment and flow through separate sample lines to the sampling room. A delay is provided by the length of the reactor coolant sample lines to provide sufficient elapsed time for N-16 decay. The samples pass through the containment to the Auxiliary Building, and into the Sampling Room, where they are cooled (pressurizer steam samples condensed and cooled) in the sample heat exchangers. The sample stream pressure is reduced by a manual throttling valve located downstream of each sample pressure vessel. The sample stream is purged to the volume control tank in the CVCS until sufficient volume has passed to permit collection of a representative sample. After sufficient purging, the sample pressure vessel is isolated for laboratory analysis of the contents or degassed, depending on the analysis required.

Alternately, these liquid samples may be collected by bypassing the sample pressure vessels. After sufficient volume has passed to the volume control tank to permit collection of a representative sample, a portion of the sample flow is diverted to the sample sink where the sample is collected.

Samples from the accumulators in the SIS pass through the containment, to the Auxiliary Building, and into the Sampling Room. The sample stream is purged until sufficient volume has passed to permit collection of a representative sample. After sufficient purging, samples are obtained at the sample sink.

The reactor coolant samples originating from the RHRS have remote operated, normally closed air-operated sampling valves located

close to the sample sources. The sample lines from these sources are connected to the sample lines coming from the reactor coolant loops at a point upstream of the sample heat exchanger. Samples from this source can be collected either in the sample pressure vessel or at the sample sink as with reactor coolant loop samples.

Liquid samples originating at the CVCS letdown line at the mixed bed demineralizer inlet and outlet headers are purged directly to the volume control tank. Samples are obtained by diverting a portion of the flow to the sample sink. If the pressure is low in the letdown line, the purge flow is directed to the Waste Disposal System (WDS).

The sample line from the gas space of the volume control tank delivers gas samples to the volume control tank sample pressure vessel in the Sampling Room. Purge flow for these samples is discharged to the vent header in the WDS.

The steam generator blowdown samples originate from locations inside the containment, flowing through lines to the sampling area in the Auxiliary Building. Each line is equipped with a manual valve close to the source, a remote air-operated valve downstream of the manual valve, an automatic containment boundary isolation valve located outside the containment and manual valves located inside the sampling area for component isolation, flow control and routing. These sample lines also contain a sample heat exchanger for cooling. A blowdown sample from each steam generator is reduced in pressure and is continuously monitored for radioactivity level, pH, and conductivity.

The steam generator samples originate from locations outside the containment, flowing through lines to the sampling area in the Auxiliary Building. Each line is provided with a manual valve close to the source and manual valves located inside the sampling area for component isolation and flow control. These sample lines also contain a sample heat exchanger for condensing and cooling.

The sample sink, which is located in the Sampling Room, contains a drain line to the WDS.

9.3.2.2.3 Components

A summary of principal component data is given in Table 9.3-2.

Sample Heat Exchangers

Eleven sample heat exchangers are installed in the system. Each heat exchanger is designed to cool the sample flow to a maximum of 127°F before the sample reaches the sample vessel or sample sink.

The sample heat exchangers are of the shell and coil tube type. Sample flow circulates through the tube side, while component cooling water circulates through the shell. The tubes and other surfaces in contact with sample flow are austenitic stainless steel while the shell is carbon steel. The inlet and outlet tube sides have socket-welded joints for connections to the high pressure sample lines.

Sample Pressure Vessel

The sample vessel is designed to receive liquid or gas samples at RCS design pressure and temperature. The sample vessel is sized to contain sufficient gas to perform a radiochemical analysis on the volume control tank gas space constituents or sufficient reactor coolant for dissolved hydrogen and fission gas analyses.

Integral isolation valves are furnished with the sample vessel.

Sample Sink

The sample sink is located in a hooded enclosure which is equipped with an exhaust ventilator. The work area around the sink and the enclosure is large enough for sample collection and storage for radiation monitoring equipment. The sink perimeter has a raised

edge to contain any spilled liquid. The enclosure is penetrated by sample lines and by a demineralized water line, all of which discharge into the sink.

Piping and Fittings

All liquid and gas sample lines are austenitic stainless steel tubing and are designed for high pressure service. Lines are so located as to protect them from accidental damage during routine operation and maintenance.

Valves

Stop valves within the containment are remotely operated from the Sampling Room. They are used to isolate all sampling points and to route sample fluid flow. The remotely operated isolation valve used for sampling from the RHRS is provided so that the operator does not have to enter a possibly high radiation area following a LOCA.

Stop valves are provided for component isolation and flow path control at all Sampling System locations which are normally accessible. A check valve in the sample line prevents accidental overpressurization of the RHRS by preventing back flow from the RCS, should both the air-operated sample valves be open.

Two isolation valves are provided, one inside and one outside the containment on all sample lines leaving the containment except for the steam generator blowdown lines which have one isolation valve outside the containment on each line. The valve trip closes upon actuation of the containment isolation signal.

All valves in the system are constructed of austenitic stainless steel or equivalent corrosion-resistant material.

9.3.2.3 System Evaluation

The Sampling System is not required to function during an emergency, nor is it required to take action to prevent any emergency condition.

Samples are collected under a hood provided with a vent to the building Exhaust Ventilation System. Liquid leakage in the sample sink is collected in the sink and drained to the WDS. Any leakage from the system inside of the containment (i.e., valve stem leakage) is collected in the containment sump.

The Sampling Room and the sample hood are ventilated to reduce the potential for airborne radioactive exposure of operating personnel.

Sufficient length is provided in the reactor coolant sample line to reduce personnel exposure from short-lived radionuclides. Shielding is provided as necessary to reduce personnel exposures. The operating procedures will specify the precautions to be observed when purging and drawing samples.

The system is designed to be operated on an intermittent basis under administrative control except for steam generator blowdown sampling which is a continuous operation. The system is normally closed with no flow, except for the steam generator blowdown samples. Sample lines penetrating the containment are equipped with remote-operated isolation valves which close on receipt of a containment isolation signal.

In the event of a LOCA, the malfunctions or failures presented in Table 9.3-3 could occur without loss of integrity of the containment.

9.3.2.4 Tests and Inspection

System operation is verified by normal, periodic collection of samples.

9.3.2.5 Instrumentation and Control

Local instrumentation is provided to permit manual control of sampling operations and to ensure that the samples are at suitable temperatures and pressures before diverting flow to the sample sink.

9.3.3 Equipment and Floor Drainage System

9.3.3.1 Design Bases

Equipment and floor drains are provided to drain radioactively contaminated water into sumps for transfer to the Liquid Waste Disposal System (See Section 11.2). In many cases equipment drainage is provided by permanently installed lines which eliminate (or reduce) surface and airborne contamination. Permanently piped equipment vents are also provided to enable various mechanical components to be vented to the respective building Ventilation System to preclude the direct release of potentially radioactive gases to the building atmosphere.

9.3.3.2 System Description

The contaminated floor drains and equipment vents and drains flow diagrams are shown on Plant Drawings 205227, 205327, 205226 and 205326.

All liquid drains originating in the Containment and Auxiliary Buildings are considered potentially radioactive and are therefore drained to the Liquid Waste Disposal System. The drain connections on nearly all components within these areas are permanently piped to the equipment drain system. Exceptions include some room cooler condensate drain piping, the Component Cooling System and certain portions of the

CVCS containing 12 percent boric acid. Hose connections are provided where it is impractical to have a permanently piped drain in which case equipment drains can be temporarily connected by hose to a local floor drain. These provisions eliminate or reduce the possibility of inadvertently allowing radioactive drains to contaminate concrete floor areas and the building atmosphere.

Condensate drain piping from room cooler drip pans is extended to the floor for free discharge to the nearest existing floor drains.

In the Auxiliary Building the floor drains at Elevations 84 feet, 100 feet and 122 feet are piped to the waste holdup tanks. Elevation 64 foot drains are piped to the waste holdup tanks via the Auxiliary Building sump tanks and sump tank pumps. All drains below the elevation of the Auxiliary Building sump tank drain to the waste holdup tank via the Auxiliary Building sump and the Auxiliary Building sump pump.

A floor drain, 4 inches in diameter, in the immediate vicinity of each charcoal filter bank, directs the drainage or deluge water to the waste holdup tanks, either directly or via sump pumps.

In the Containment Building, all equipment drains to the WDS from the containment sump.

In the Fuel Handling Building, the equipment drains are piped to the WDS via a fuel handling area sump.

With the exception of Nuclear Steam Supply System (NSSS) tanks that are blanketed with nitrogen, all tanks containing potentially contaminated waste are permanently vented to the suction side of the Auxiliary Building exhaust fans. This ensures that the tanks are maintained at a slight negative pressure to eliminate the possibility of introducing airborne contamination to the Auxiliary Building atmosphere.

9.3.3.3 System Design

The contaminated floor and equipment drain piping was originally designed to ASME/ANSI B31.1, while material selection, fabrication, inspection, testing, installation and quality controls were in accordance with ASME/ANSI B31.7. The original design classification of the system was based on early interpretation of the Regulatory Guides during the construction period, and the system was classified to be non-safety related, Nuclear Class III and non-seismic. Based on the current revisions of the Regulatory Guides and ANSI standards, the system has been reclassified to be non-safety related, non-Nuclear (Quality Group D) and non-seismic. Supplemental quality assurance requirements (Augmented D) have been incorporated to the applicable piping specification section to maintain the quality level recommended by Regulatory Guide 1.143.

THIS PAGE INTENTIONALLY LEFT BLANK

9.3.4 Chemical and Volume Control System

The CVCS is used to 1) adjust the concentration of boric acid, i.e., the chemical neutron absorber for reactivity control, 2) maintain the proper water inventory in the RCS, 3) provide the required seal water flow for the reactor coolant pump shaft seals, 4) process reactor coolant letdown for reuse of boric acid and reactor makeup water, 5) maintain the proper concentration of corrosion-inhibiting chemicals in the reactor coolant, 6) maintain the reactor coolant activities to within design limits, and 7) provide borated water for safety injection. The system is also used to fill and hydrostatically test the RCS. In addition, the system is used to provide reactivity management, normal RCS make-up, and RCP seal injection flow through the cross-tied portions to support a safe shutdown of the opposite unit if it loses its charging capability due to a fire.

During normal operation, this system also has provisions for supplying the following chemicals:

1. Regenerant chemicals to the evaporator condensate and deborating demineralizers

2. Hydrogen to the volume control tank

3. Nitrogen as required for purging the volume control tank

4. Hydrazine hydrogen peroxide and lithium hydroxide as required via the chemical mixing tank to the charging pumps suction

9.3.4.1 <u>Design Bases</u>

9.3.4.1.1 Redundancy of Reactivity Control Systems

Two independent Reactivity Control Systems, preferably of different principles, shall be provided.

In addition to the reactivity control achieved by the rod cluster control assemblies (RCCA) as detailed in Sections 7 and 4, reactivity control is provided by the CVCS which regulates the concentration of boric acid solution neutron absorber in the RCS.

9.3.4.1.2 Reactivity Hold-Down Capability

The Reactivity Control Systems provided shall be capable of making the core subcritical under credible accident conditions with appropriate margins for contingencies and limiting any subsequent return to power such that there will be no undue risk to the health and safety of the public.

Normal reactivity shutdown capability is provided by control rods with boric acid injection used to compensate for the long-term xenon decay transient and for plant cooldown. Any time that the plant is at power, the quantity of boric acid retained in the boric acid tanks and ready for injection always exceeds that quantity required for the normal cold shutdown. This quantity always exceeds the quantity of boric acid required to bring the reactor to hot shutdown and to compensate for subsequent xenon decay.

The system is designed to allow for concurrent mixing and subsequent injection of boric acid solution. Thus the CVCS provides extended reactivity hold-down capability.

9.3.4.1.3 Reactivity Hot Shutdown Capability

The Reactivity Control Systems provided shall be capable of making and holding the core subcritical from any hot standby or hot operating condition.

The Reactivity Control Systems provided are capable of making and holding the core subcritical for any hot standby or hot operating condition, including those resulting from power changes.

The chemical shim control serves to provide hot shutdown for the reactor as backup to the RCCAs.

9.3.4.1.4 Reactivity Shutdown Capability

The Reactivity Control Systems provided shall be capable of making the core subcritical under credible accident conditions with appropriate margins for contingencies and limiting any subsequent return to power such that there will be no undue risk to the health and safety of the public.

The sizing of the CVCS components and redundancy of its components and flow paths determines the CVCS reactor shutdown capability.

The boric acid solution is transferred from the boric acid tanks by boric acid transfer pumps to the suction of the charging pumps which inject boric acid into the RCS. Any charging pump and any boric acid transfer pump can be operated from diesel generator power on loss of primary power.

On the basis of the above, the injection of boric acid is shown to afford backup shutdown reactivity capability, independent of control rod clusters which normally serve this function in the short-term situation. Shutdown for long terms and reduced temperature conditions can be accomplished with boric acid injection using redundant components.

9.3.4.1.5 Codes and Classifications

All pressure retaining components (or compartments of components) of the CVCS which are exposed to reactor coolant comply with the following codes:

1. System pressure vessels - ASME Boiler and Pressure Vessel Code, Section III, Class C.

2. System valves, fittings and piping - ANSI B31.1 (for design). For piping not supplied by the NSSS supplier, material inspections, fabrication and quality control conform to ANSI B31.7. Where not possible to comply

with ANSI B31.7, the requirements of ASME III-1971, which incorporated ANSI B31.7,. were adhered to.

System integrity is assured by conformance to applicable codes listed in Table 9.3-4, and by the use of austenitic stainless steel or other corrosion-resistant materials in contact with both reactor coolant and boric acid solutions.

The regenerative heat exchanger and the tube side of the excess letdown heat exchanger are designed as ASME III, Class C. This designation is based on the following considerations:

1. Each exchanger can be isolated from the RCS.

2. Each is located inside the reactor containment, and

3. Both exchangers are protected by a missile barrier.

Accordingly, the designation of "Class C" for these exchangers is justifiable and does not lead to any public hazard.

9.3.4.2 System Design and Operation

The CVCS shown on Plant Drawings 205228, 205328, 205229, 205329, 205230 and 205330 provides a means for injection of soluble neutron adsorber in the form of boric acid solution, chemical additions for corrosion control and reactor coolant cleanup and degasification. This system also provides a means to add makeup water to the RCS, reprocesses water letdown from the RCS, provides seal water injection to the reactor coolant pump seals, and fills and hydrostatically tests the RCS. In addition, the system is used to provide reactivity management, normal RCS make-up, and RCP seal injection flow through the cross-tied portions to support a safe shutdown of the opposite unit if it loses its normal charging capability due to a fire. The CVCS system is capable of supporting safe power operation and, at the same time, supporting the opposite unit’s safe shutdown.

System components whose design pressure and temperature are less than the RCS design limits are provided with overpressure protective devices.

System discharge from overpressure protective devices and system leakages are directed to closed systems. Effluents removed from such closed systems are monitored and discharged under controlled conditions.

System design enables post-operational hydrostatic testing to test pressure required by the codes listed in Table 9.3-4.

9.3.4.2.1 System Description

During plant operation, reactor coolant flows through the letdown line from one of the reactor coolant loop cold legs on the suction side of the reactor coolant pump and is returned through the charging line to the cold leg of another loop. An alternate return path is provided to the cold leg of a different loop (see Plant Drawings 205228 and 205328). An excess letdown line is also provided as an alternate in case the normal letdown circuit is inoperative or it can be used to supplement maximum letdown during final stages of heatup.

Each of the CVCS connections to the RCS has an isolation valve. In addition, a check valve is located downstream of each charging line isolation valve. Reactor coolant entering the CVCS flows through the shell side of the regenerative heat exchanger where its temperature is reduced. The coolant then flows through a letdown orifice which reduces the coolant pressure. The cooled, low pressure water leaves the reactor containment and enters the Auxiliary Building where it undergoes a second temperature reduction in the tube side of the letdown heat exchanger followed by a second pressure reduction by the low pressure letdown valve. After passing through one of the demineralizers, where ionic impurities are removed, coolant flows through the reactor coolant filter and enters the volume control tank through a spray nozzle.

Hydrogen is automatically supplied, as determined by pressure control, to the vapor space in the volume control tank, which is

predominantly filled with hydrogen and water vapor. The hydrogen within the tank is, in turn, the supply source to the reactor coolant. Fission gases are removed from the system by venting the volume control tank to the WDS prior to a cold or refueling shutdown.

During plant shutdown, dissolved hydrogen in the RCS must be removed prior to opening the RCS for maintenance or refueling. Hydrogen removal can be performed in either or a combination of the following methods: 1) The VCT level can be raised and lowered repeatedly to "burp" the hydrogen-rich VCT gas space to the WDS. When the level is lowered, fresh nitrogen is admitted to the gas space. 2) Hydrogen peroxide is added to the RCS to react with the dissolved hydrogen to form water.

If there is uncertainty concerning the removal of hydrogen, then additional monitoring, actions, and precautions will be performed during opening of the component for refueling or maintenance to ensure safe conditions are established.

To enter the RCS the coolant flows from the volume control tank to the charging pumps which raise the pressure above that in the RCS. The coolant then enters the containment, passes through the tube side of the regenerative heat exchangers, and returns to the RCS. A portion of the high pressure charging flow is filtered and injected into the reactor coolant pumps between the pump impeller and the shaft seal so that the seals are not exposed to particulate matter in the reactor coolant. Part of the flow cools the lower radial bearing and enters the RCS through a labyrinth seal on the pump's shaft. The remainder, which is the shaft seal leakage flow, is filtered, cooled in the seal water heat exchanger and returned to the suction of the charging pumps. An alternate path provides means for returning seal water to the volume control tank.

Coolant injected through the reactor coolant pump labyrinth seals joins with the reactor coolant. An equal amount of reactor coolant returns to the volume control tank by the normal letdown flow path through the regenerative heat exchanger. When the normal letdown route is not in service, this reactor coolant letdown returns to the suction of the charging pumps through the excess letdown and seal water heat exchangers.

The cation bed demineralizer, located downstream of the mixed bed demineralizers, may be used intermittently to control cesium activity in the coolant and also to remove excess lithium which is formed from the B^{10} (n, α) Li^{7} reaction.

Boric acid is dissolved in water in the batching tank to a concentration between 3.75 to 4.0 weight percent. The batching tank is jacketed to permit heating of the batching tank solution with low pressure steam. One of two boric acid transfer pumps is used to transfer the batch to the boric acid tanks. Small quantities of boric acid solution are metered from the discharge of an operating boric acid transfer pump for blending with the water supplied to makeup for normal leakage, or for increasing the reactor coolant boron concentration during normal operation. Electric immersion heaters maintain the temperature of the solution in the boric acid tanks high enough to prevent precipitation.

During plant startup, normal operation, load reductions and shutdowns, liquid effluents containing boric acid flow from the RCS through the letdown line and are collected in the holdup tanks or the volume control tank. As liquid enters the holdup tanks, the nitrogen cover gas is displaced to the gas decay tanks in the WDS through the waste vent header. The concentration of boric acid in the holdup tanks varies throughout core life from the refueling concentration to essentially zero at the end of the core cycle. A recirculation pump is provided to recirculate and transfer liquid from one holdup tank to another.

Liquid effluent in the holdup tanks is processed through a recycle processing train. This liquid is pumped by the gas stripper feed pumps through the evaporator feed ion exchangers which primarily remove lithium and long-lived cesium. Additional ion exchange resin may be used to enhance removal if isotopes such as cobalt. The liquid then flows through the ion exchanger filter, and into the gas stripper section of the combined boric acid evaporator gas stripper package where dissolved gases are removed from the liquid. These gases are vented to the Gaseous Waste Disposal System.

The liquid effluent from the gas stripper section enters the boric acid evaporator.

The vapor produced in the boric acid evaporator leaves the evaporator condenser and is pumped through a condensate cooler where the distillate is cooled to the operating temperature of the evaporator distillate demineralizers. After non-volatile

evaporator carryover is removed by one of the two evaporator distillate demineralizers, the distillate then flows through the distillate filter and accumulates in one of the two monitor tanks. The evaporator bottoms left behind in the boric acid evaporator are concentrated to approximately 12 weight percent boric acid.

Subsequent handling of the condensate is dependent on the results of sample analysis of the monitor tank contents. Discharge from the monitor tanks may be pumped by either of the two monitor tank drain pumps to the primary water storage tank, recycled through the evaporator distillate demineralizers, returned to the holdup tanks for reprocessing in the evaporator train or, if the sample analysis of the monitor tank contents indicates sufficiently low levels, the contents may be discharged to the environment via the WDS (Section 11).

Boric acid evaporator bottoms are discharged through a concentrates filter to the concentrates holding tank to the Boric Acid Storage Tanks or the hold-up tanks, depending on sample analysis and plant requirements.

The concentrated solution can also be pumped from the evaporator to the WDS portable demineralizer or waste evaporator for additional reprocessing before being placed in containers. These containers can then be stored at the station site for ultimate shipment offsite for disposal.

The CVCS demineralizers can be used intermittently to remove boron from the reactor coolant near the end of core life when boron concentration is low. When the deborating demineralizers are in operation, the letdown stream passes through the mixed bed demineralizers and then through the deborating demineralizers and into the volume control tank after passing through the reactor coolant filter.

During shutdown, hydrogen peroxide is added to the RCS via the Chemical Mixing Tank to dissolve radionuclides and non-radioactive metals from piping and equipment to allow their removal by the CVCS demineralizers.

During plant cooldown when the residual heat removal loop is operating and the letdown orifices are not in service, a flow path is provided to remove fission products, corrosion products and other impurities. A portion of the flow leaving the residual heat exchangers passes through the letdown heat exchanger, demineralizers, reactor coolant filter and volume control tank. The fluid is then pumped via the charging pump through the tube side of the regenerative heat exchanger into the RCS.

During normal operation, the isolation valves on the charging and BAST cross-ties between the units are kept shut to maintain separation between units.

The cross-ties enhance plant safety by allowing the CVCS in one unit to be an alternate source of high pressure, borated water to the opposite unit. This allows, even with a total loss of its own charging pumps, for a unit to be safely shutdown. This charging flow satisfies reactivity management, normal RCS make-up, and RCP seal injection.

Furthermore, the design provides the capability for separation of the C/SI pump and PD pump flow paths for cooldown and boration from the BAST to achieve cold shutdown of the opposite unit. Separation of the PD pump allows for a unit to continue safe power operation using its C/SI pumps with the PD pump used to achieve cold shutdown of the opposite unit. When separated, the C/SI pumps are aligned to the VCT to provide normal charging, while the PD pump takes suction from either the RWST or the BAST thus providing charging to the opposite unit via the cross-tie. The charging line to the opposite unit is normally isolated by a check valve and normally shut MOV. The MOV can be operated from the control room to minimize any delay in starting charging to the opposite unit. The BAST cross-tie between units allows the BAST from the unit being shutdown to be the source of borated water to the PD pump to minimize the impact on the RWST.

The operation of the cross-tied boration system and charging system is controlled manually as necessary in accordance with station procedures.

9.3.4.2.2 Expected Operating Conditions

Tables 9.3-5 and 9.3-6 list the system performance requirements and data for individual system components respectively.

9.3.4.2.3 Reactor Coolant Activity Concentration

The parameters used in the calculation of the reactor coolant fission product inventory, including the expected coolant cleanup flow rate and the demineralizer effectiveness, are presented with the results of the calculations in Appendix I. In these calculations the defective fuel rods are assumed to be present at core loading uniformly distributed throughout the core. The fission product escape rate coefficients are therefore based upon an average fuel temperature.

Tritium is produced in the reactor from ternary fission in the fuel, irradiation of boron in the burnable poison rods (during initial fuel cycle only), irradiation of boron in the control rods, and irradiation of boron, lithium and deuterium in the coolant.

9.3.4.2.4 Reactor Makeup Control Modes

The reactor makeup control is designed to operate from the Control Room by manually preselecting makeup composition to the charging pump suction header or the volume control tank in order to maintain the desired operating fluid inventory in the volume control tank and to adjust the reactor coolant boron concentration for reactivity control. The operator can stop the makeup operation at any time in any operating mode by remotely closing the makeup stop valves or depressing the makeup mode selector stop pushbutton.

Makeup water to the RCS is provided by the CVCS from the following sources:

1. The primary water storage tank, which provides water for dilution when the reactor coolant boron concentration is to be reduced.

2. The boric acid tanks, which supply concentrated boric acid solution when the reactor coolant boron concentration is to be increased.

3. The refueling water storage tank which supplies borated water for emergency makeup.

4. The chemical mixing tank, which is used to inject small quantities of solution when additions of hydrazine hydrogen peroxide or pH control chemical (Li^7OH) are necessary.

Makeup for normal plant leakage is regulated by the reactor makeup control which is set by the operator to blend water from the primary water storage tank with concentrated boric acid to match the reactor coolant boron concentration. Makeup is added automatically if the volume control tank level falls below a preset point.

Automatic Makeup

The "automatic makeup" mode of operation of the reactor primary water makeup control provides boric acid solution present to match the boron concentration in the RCS. The "automatic makeup" compensates for minor leakage of reactor coolant without causing

significant changes in the coolant boron concentration.

The operator sets the following equipment in the automatic position:

1. Either primary water makeup pump

2. Either boric acid transfer pump

3. Boric acid flow control valve

4. Primary water flow control valve

5. Charging suction makeup valve

6. Makeup mode selector

By depressing the start pushbutton of the makeup mode selector, the following actions occur when a low level signal is received from the volume control tank:

1. The boric acid transfer pump is switched to high speed and the primary water makeup pump is switched on.

2. The boric acid flow control valve is switched to its respective flow controller.

3. The primary water flow control valve is unblocked.

4. The charging suction makeup valve is open.

The flow controllers then blend the makeup stream according to the present concentration. Makeup addition to either the charging pump suction header or the spray line to the volume control tank causes the water level in the volume control tank to rise. After the level in the volume control tank is restored, the primary water flow control valve closes, the boric acid transfer pump is

returned to low speed operation, the boric acid flow control valve returns to the full open position, and the charging suction makeup valve closes.

Dilution

The "dilute" mode of operation permits the addition of a preselected quantity of reactor primary water makeup at a preselected flow rate to the RCS. The operator sets the following equipment in the automatic position:

1. Either primary water makeup pump

2. The primary water flow control valve

3. The volume control tank makeup valve

He then selects the setpoint for the primary water makeup flow rate and the total quantity of makeup water desired on the primary water flow register. By depressing the "dilute" and start pushbuttons on the makeup mode selector, the following actions are initiated:

1. The primary water makeup pump is switched on.

2. The primary water flow control valve is unblocked.

3. The boric acid flow control valve is closed if it is in the automatic position.

4. The volume control tank makeup valve is opened.

This provides a regulated supply of unborated primary water to the volume control tank which subsequently goes to the charging pump suction header. When the preset quantity of primary water makeup has been added, the primary water flow register causes the primary

water makeup pump to stop, the primary water flow control valve to close, and the volume control tank makeup valve to close.

The volume control tank level is controlled by a three-way valve which normally modulates flow between the volume control tank and the holdup tanks with a level controller. In the event the level becomes abnormally high, the entire flow is diverted to the holdup tanks.

Alternate Dilution

The "alternate dilute" mode of operation provides a more rapid reduction of boric acid concentration than the "dilute" mode. This is accomplished by opening both the charging suction makeup valve and the volume control tank makeup valve. The operation is the same as described for the "dilute" mode except the operator must have the charging suction makeup valve in the automatic position in addition to the equipment listed for the "dilute" mode, and he must depress the "alternate dilute" pushbutton of the makeup mode selector instead of the "dilute" pushbutton. To provide a more rapid boron reduction rate, the operator can take manual control and close valve CV181 thereby directing all dilution flow to the charging pump suction.

Boration

The "borate" mode of operation permits the addition of a preselected quantity of concentrated boric acid solution at a preselected flow rate to the RCS. The operator sets the following equipment in the automatic position:

1. Either boric acid transfer pump
2. The charging suction makeup valve
3. The boric acid control valve

He then selects the setpoint for the concentrated boric acid flow rate and the total quantity of concentrated boric acid desired on the boric acid flow register. By depressing the "borate" and

start pushbuttons of the makeup mode selector the following actions are initiated:

1. The boric acid transfer pump is switched to high speed.

2. The boric acid flow control valve is switched to its respective flow controller.
3. The charging suction makeup valve is opened.

This provides a regulated supply of 3.75 to 4.0 weight percent boric acid solution to the charging pump suction header. The total quantity added in most cases will be so small that it will have only a minor effect on the volume control tank level. When the preset quantity of concentrated boric acid solution has been added, the boric acid flow register causes the boric acid transfer pump to return to low speed operation and closes the charging suction makeup valve and returns the boric acid flow control valve to the full open position. In the event of a volume control tank low-low level signal, the suction of the charging pumps is automatically aligned to take suction from the refueling water storage tank.

The maximum rate of boration with the two centrifugal charging pumps delivering water from the refueling water storage tank at a concentration of 2000 ppm boron is 9 ppm per minute. This compensates for a cooldown rate of 2°F per minute at the end of core life when the moderator temperature coefficient is most negative. By comparison, normal cooldown rates are about 0.8°F per minute.

The rate of boration of the primary system with 45 gpm from a boric acid transfer pump directed to the charging pump suction is 4.8 ppm per minute, which is above the required value for normal cooldowns.

Deviation of reactor primary water makeup flow rate from the control setpoint and deviation of concentrated boric acid flow rate from the control setpoint are alarmed on the main control board.

Boration During Cooldown

Boration during cooldown may be performed as an alternative to boration prior to cooldown per amendments 145/133.

This methodology does not require the use of the non-safety letdown line, and it minimizes the amount of Boric Acid Tank volume required to borate the RCS. The methodology is described in detail in Reference 2.

If boration during cooldown is selected, the sole source of RCS cooldown contraction make-up must be undiluted boric acid until the Technical Specification BAT volume is added. Thereafter, the make-up concentration is varied depending on the desired end point concentration.

To use undiluted boric acid as RCS makeup, the "automatic make-up" mode is selected as previously described except that (1) both primary water make-up pumps are placed in manual and (2) the primary water flow control valve setpoint is adjusted to zero gpm.

The RCS make-up system will respond to VCT level signals as described in "automatic mode" except that the PWST pump will not operate and the primary water flow control valve will remain closed. Undiluted boric acid will be sent through the blender to the VCT as the RCS make-up.

Opposite Unit Safe Shutdown

When using the cross-ties to conduct a safe shutdown of the opposite unit, the "boration during cooldown" methodology is credited with the following differences:

The BAST cross-tie isolation valves are opened. The 11(21) BAT pump, in the unit providing the PD pump, is aligned to take suction from the BAST of the unit being shutdown. The 11(21) BAT pump discharge is then aligned to the PD pump suction through a line that discharges downstream of 1(2)CV57, the isolation valve for the PD pump suction branch line. This allows the 11(21) BAT pump to supply concentrated boric acid to the PD pump without affecting the VCT boron concentration.

The PD pump dedicated RWST suction line gate valve need not be shut since the check valve will prevent back flow to the RWST. In this line up, undiluted boric acid is charged to the opposite unit as long as the PD pump is operated within the flow capacity of the BAT pump. This may limit the cooldown rate until the required BAST volume is added. Once the BAT pump flow to the PD pump is stopped, the PD pump will draw suction from the RWST.

9.3.4.2.5 Charging Pump Control

Positive Displacement Charging Pump

The PD pump is available in modes 1 - 4 to support either normal charging in its unit, or safe shutdown of the opposite unit. For opposite unit use, the pump suction is first aligned to the RWST through the safety injection suction path in the short term, then aligned to the RWST or BAST through dedicated suction lines with normally closed valves.

Since the BAST and RWST are both non-pressurized tanks vented to the atmosphere, packing leakage should not cause an airborne radiological concern.

During modes 5 and 6, the PD pump can provide normal charging and to serve as the boration flow path for its own unit. Also, the PD pump may be used to support safe shutdown of the opposite unit.

The positive displacement charging pump has a variable speed drive and has the capability of providing normal charging to the RCS. The speed of this pump can be controlled manually, or automatically by pressurizer level. During load changes, the pressurizer level setpoint varies automatically with T_{avg}, compensating partially for the expansion or contraction of reactor coolant associated with T_{avg} changes. Charging pump speed will not change rapidly with pressurizer level controller. If the pressurizer level increases, the speed of the pump decreases; conversely, if the level decreases, the speed increases. When using the positive displacement charging pump to charge to the opposite unit, the speed control must be set in manual. In normal operation, if flow demand exceeds the capacity of the positive displacement charging pump, it becomes necessary to transfer operation to a C/SI pump. Transfer is achieved by first running both pumps in parallel, and then stopping the PD pump.

To ensure that the charging pump flow is always sufficient to meet the seal water flow requirements of the reactor coolant pumps, the pump has a low speed stop which prevents pump flow lower than the specified minimum.

Centrifugal Charging Pumps

The centrifugal pumps are constant speed pumps with flow control accomplished by a modulating valve in the pump discharge line. When the positive displacement pump is in operation, this control valve is in the wide open position.

A flow transmitter on the charging line upstream of the regenerative heat exchanger transmits a signal to a controller which regulates a modulating valve in the charging line to maintain a preset charging flow. A pressurizer water level error signal resets the charging flow setpoint to take corrective action. The response of the charging line modulating valve to changes in the flow control signal is normally maintained slow to reduce charging flow fluctuations due to short-term pressurizer level transients.

9.3.4.2.6 Components

A summary of principal component data is given in Table 9.3-6.

Regenerative Heat Exchanger

The regenerative heat exchanger is designed to recover heat from the letdown flow by reheating the charging flow, to eliminate reactivity effects due to insertion of cold water, and to reduce thermal shock on the charging penetrations into the reactor coolant loop piping.

The design also considers the limit of difference in temperature which occurs during periods when letdown flow exceeds charging flow by a greater margin than at normal letdown conditions.

The letdown stream flows through the shell of the regenerative heat exchanger and the charging stream flows through the tubes. The unit is made of austenitic stainless steel, and is of all welded construction. It is a multi-shell U-tube type heat exchanger using three shells.

Letdown Orifices

One of the three letdown orifices controls flow of the letdown stream during normal operation and reduces the pressure to a value compatible with the letdown heat exchanger design. Two of the letdown orifices are designed to pass normal letdown flow. The third orifice is designed to be used in conjunction with one normal letdown flow orifice to maintain maximum purification flow at normal RCS operating pressure. The orifices are placed in and taken out of service by remote manual operation of their respective isolation valves. The standby orifice may be used in parallel with the normally operating orifice in order to increase letdown flow when the RCS pressure is below normal. This arrangement provides a full standby capacity for control of letdown flow. Each orifice is an austenitic pipe containing a bored corrosion-and erosion-resistant insert.

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. The letdown stream outlet temperature is automatically controlled by a temperature control valve in the component cooling water outlet stream. The unit is a multiple-tube-pass heat exchanger. All surfaces in contact with the reactor coolant are austenitic stainless steel, and the shell is carbon steel.

Mixed Bed Demineralizers

Two flushable mixed bed demineralizers assist in maintaining reactor coolant purity. A cation resin (Lithium or hydrogen form) and a hydroxyl form anion resin may be used in the demineralizers. Both forms of resin remove fission and corrosion products. The resin is designed to reduce concentration of ionic isotopes in the purification stream except for cesium, yttrium and molybdenum, by

a minimum factor of 10 during power operation. The anion resin rapidly converts to a borate form and thereafter does not remove boron from the reactor coolant.

Each demineralizer is sized to accommodate the maximum letdown flow.

Alternately, approved, application-specific resins capable of enhanced particle removal, layered atop either an anion or mixed bed resin underlay, may be used.

The demineralizer vessels are provided with suitable connections to facilitate resin replacement when required. The vessels are equipped with a resin retention screen. Each demineralizer has sufficient capacity for approximately one core cycle with one percent defective fuel rods.

Cation Bed Demineralizer

A flushable cation bed demineralizer is located downstream of the mixed bed demineralizers and may be used intermittently to control the concentration of Li^7 which builds up in the coolant from the B^{10} (n, α) Li^7 reaction. The demineralizer also has sufficient capacity to maintain the cesium-137 concentration in the coolant below 1.0 μc/cc with 1 percent defective fuel. The demineralizer MAY BE used intermittently to control cesium.

The demineralizer vessel is provided with suitable connections to facilitate resin replacement when required. The vessel is equipped with resin retention screens. The cation bed demineralizer has sufficient capacity for approximately one core cycle with 1 percent defective fuel rods.

Resin Fill Tank

The resin fill tank is mobile and is used to charge fresh resin to the demineralizers. The line from the conical bottom of the tank is fitted with a valve and a flexible hose spool piece that may be connected to any one of the demineralizer fill lines. The

demineralizer water and resin slurry can then be sliced into the demineralizer by opening the valve.

Reactor Coolant Filter

The filter collects resin fines and particulates from the letdown stream. The vessel is provided with connections for draining and venting. The nominal flow capacity of the filter is equal to the maximum purification flow rate. Disposable synthetic filter elements in a cage assembly are used.

Volume Control Tank

The volume control tank is an operating surge volume compensating in part for reactor coolant releases from the RCS as a result of level changes. The volume control tank also acts as a head tank for the charging pumps and a reservoir for the leakage from the reactor coolant pump controlled leakage seal. Overpressure of hydrogen gas is maintained in the volume control tank to control the hydrogen concentration in the reactor coolant at 25 to 50 cc per kg of water (STP). Hydrogen concentration may be reduced to 15 cc/kg 24 hours prior to a planned outage.

A spray nozzle is located inside the tank on the inlet line from the reactor coolant filter. This spray nozzle provides intimate contact to equilibrate the gas and liquid phases. A remotely operated vent valve discharging to the WDS permits removal of gaseous fission products which are stripped from the reactor coolant and collected in the tank.

Charging Pumps

Three charging pumps are provided for injection coolant into the RCS. Two are centrifugal pumps and the third is a positive displacement pump equipped with variable speed drive. All parts in contact with the reactor coolant are fabricated of austenitic stainless steel or other material of adequate corrosion resistance. The centrifugal pump packing glands and positive

displacement pump stuffing box are provided with leakoffs to collect reactor coolant. Pump leakage is piped to the drain header for disposal. The pump design prevents lubricating oil from contaminating the charging flow. The integral discharge valves on the positive displacement pump act as check valves.

The positive displacement pump is designed to provide the full charging flow and the reactor coolant pump seal water supply. The centrifugal pumps have a higher flow capacity that is capable of matching maximum letdown or purification flows. Each pump is designed to provide rated flow against a pressure equal to the sum of the RCS normal maximum pressure (existing when the pressurizer power operated relief valve is operating) and the piping, valve, and equipment pressure losses at the design charging flows. A suction stabilizer and pulsation dampener are provided on the suction and discharge, respectively, of the positive displacement pump to attenuate the inherent pressure pulsations that are caused by the reciprocating actions of the pump.

The positive displacement charging pump is used to hydrotest the RCS.

Under normal conditions, either the positive displacement charging pump or a centrifugal charging pump will take suction from the volume control tank and discharge to the normal charging and reactor coolant pump seal water injection paths. Flow control for the positive displacement pump is accomplished by varying the pump speed. If the positive displacement pump is not used, one of the centrifugal charging pumps is operated. The flow paths remain the same, but flow control is accomplished by a modulating valve on the discharge side of the centrifugal pumps. A centrifugal charging pump is operated to provide charging when maximum letdown or purification is required. The centrifugal charging pumps also serve as safety injection pumps in the Emergency Core Cooling System (Section 6).

Chemical Mixing Tank

The primary use of the chemical mixing tank is for the injection of various chemicals for RCS water chemistry control. These include the injection of caustic solutions for ph control, hydrazine for oxygen scavenging and hydrogen peroxide for chemical degassing and corrosion product solubilization.

The capacity of the chemical mixing tank is determined by the quantity of 35 percent hydrazine solution necessary to increase the hydrazine concentration in the reactor coolant by 10 ppm. This capacity is more than sufficient to prepare solution of pH control chemical for the RCS.

Excess Letdown Heat Exchanger

The excess letdown heat exchanger cools an amount of reactor coolant letdown equal to the nominal injection rate through the reactor coolant pump labyrinth seal, if letdown through the normal letdown path is not usable. The unit is designed to reduce the letdown stream temperature from the cold leg temperature to 195°F. The letdown stream flows through the tube side and component cooling water is circulated through the shell side. All surfaces in contact with the reactor coolant are austenitic stainless steel and the shell is carbon steel. All tube joints are welded.

Seal Water Heat Exchanger

The seal water heat exchanger removes heat from several sources: the reactor coolant pump seal water returning to the volume control tank, the reactor coolant discharge from the excess letdown heat exchanger and the centrifugal charging pump bypass flow. Reactor coolant flows through the tubes and component cooling water is circulated through the shell side. The tubes are welded to the tube sheet to prevent leakage in either direction and undesirable contamination of the reactor coolant or component cooling water. All surfaces in contact with reactor coolant are austenitic stainless steel and the shell is carbon steel.

The unit is designed to cool the excess letdown flow, the pump seal water flow and the centrifugal charging pump bypass flow to the temperature normally maintained in the volume control tank.

Seal Water Filter

This filter collects particulates from the reactor coolant pump seal water return and from the excess letdown heat exchanger flow. The filter is designed to pass the sum of the excess letdown flow and the maximum design leakage from the reactor coolant pump seals. The vessel is provided with connections for draining and venting. Disposable synthetic filter elements in a cage assembly are used.

Seal Water Injection Filters

The filter collects particulates from the reactor coolant pump seal water inlet. Two filters are provided in parallel, each sized for the maximum design pump seal flow rate. The vessel is provided with connections for draining and venting. Disposable synthetic filter elements in a cage assembly are used.

Boric Acid Filter

The boric acid filter collects particulates from the boric acid solution being pumped to the charging pump suction line or boric acid blender. The filter is designed to pass the design flow of two boric acid transfer pumps operating simultaneously. The filter elements are disposable synthetic cartridges in a cage assembly. Provisions are included for venting and draining the filter.

Boric Acid Tanks

Each tank holds 8,000 gallons of boric acid

solution at a concentration of 3.75 to 4.0 percent by weight (6560 ppm to 6990 ppm). The volume required to meet cold shutdown requirements with the most reactive RCCA not inserted are in accordance with Technical Specification Figure 3.1-2 for Salem Unit 1 and Figure 3.1-2 for Salem Unit 2. The Technical Specifications state the minimum amount of boric acid required to be available. It is likely that additional boric acid solution would be prepared following either of these evolutions (cold shutdown or refueling shutdown.

Periodic manual sampling and corrective action, if necessary, ensures that these limits are maintained. As a consequence, measured amounts of boric acid solution can be delivered to the reactor coolant to control the chemical poison concentration. The combination overflow and breather vent connection has a water loop seal to minimize vapor discharge during storage of the solution.

Batching Tank

The batching tank is sized to hold makeup supply of boric acid solution for transfer to the boric acid tanks. The tank may also be used for solution storage.

A local sampling point is provided for verifying the solution concentration prior to transferring it to the boric acid tank or for draining the tank. The tank is provided with an agitator to improve mixing during batching operations. The tank is provided with a steam jacket for heating the boric acid solution to >80°F to facilitate mixing.

Boric Acid Tank Heaters

The solubility limit for 4.0 weight percent boric acid is reached at a temperature of 58°F. This temperature is sufficiently low that the normally expected ambient temperatures within the auxiliary building will maintain boric acid solubility. Heaters remain in place for manual or automatic operation in the event auxiliary building ambient temperature falls below the Technical Specification requirement.

Boric Acid Transfer Pumps

Two horizontal, centrifugal, two-speed pumps with mechanical seals are supplied. Normally, one pump is aligned with one boric acid tank and runs continuously at low speed to provide recirculation of the Boric Acid System and boric acid tank. The second pump is aligned with the second boric acid tank and is then considered as a standby pump, with service being transferred as operation requires. This second pump also intermittently circulates fluid through the second tank. Manual or automatic initiation of the Reactor Coolant Makeup System will activate the running pump to the higher speed to provide normal makeup of boric acid solution as required. For emergency boration, supplying of boric acid solution to the suction of the charging pump can be accomplished by manually choosing either fast or slow speed and actuating either or both pumps. The transfer pumps also function to transfer boric acid solution from the batching tank to the boric acid tanks.

The original pump rated flow was 75 gpm. This value was significantly above the value required for normal operations and by the safety requirements. Due to the severe service requirement associated with pumping boric acid, the Inservice testing program tests these pumps to ensure a minimum flow of 45 gallons per minute at rated pump head.

The safety requirements can be met with a flow of 33 gpm of 3.75 to 4.0 weight percent boric acid. This corresponds to a boration rate of 132 ppm/hour. This requirement is based on GDC 26 which requires a

second reactivity system "capable of controlling the rate of reactivity changes resulting from planned normal power outages (including Xenon burnout) to assure acceptable fuel limits are not exceeded. One of the systems shall be capable of holding the reactor subcritical under cold conditions." Westinghouse has established the maximum Xenon burnout rate as 132 ppm per hour.

The maximum required RCS make-up rate during normal operation is 120 gpm. This can be met without resorting to taking a suction on the RWST. One boric acid transfer pump at 45 gpm supplying 3.75 to 4.0 weight percent boric acid (6560 ppm to 6990 ppm boron) to the boric acid blender can, in conjunction with the primary water make up pumps, provide 120 gpm of make-up water well in excess of 2518 ppm to the RCS.

The boric acid transfer pump design discharge pressure is sufficient to overcome any pressures which may exist in the suction manifold of the charging pumps (volume control tank relief valve setting). In addition to the automatic actuation by the Makeup Control System and manual actuation from the main control board, these pumps also may be controlled locally.

THIS PAGE INTENTIONALLY LEFT BLANK

All parts in contact with the solution are of austenitic stainless steel. Connections are provided to enable the use of these pumps to flush the equipment and piping with primary water.

Each boric acid transfer pump is powered by a separate 460 V vital bus which is capable of being supplied by the associated diesel generator in the event of loss of offsite power.

Each boric acid transfer pump can pump from either boric acid tank. Operator action to place the plant in a cold shutdown condition with one boric acid tank unavailable would consist merely of using the other tank.

Boric Acid Blender

The boric acid blender promotes thorough mixing of boric acid solution and primary water makeup for the reactor coolant makeup circuit. The blender consists of a conventional pipe tee.

Holdup Tanks

Three holdup tanks contain radioactive liquid which enters the tanks from the letdown line. The liquid is released from the RCS during startup, shutdowns, load changes and from boron dilution to compensate for burnup. The contents of one tank are normally being processed by the gas stripper boric acid evaporator packages while another tank is being filled. The third tank is available for storage as required. Unit No. 1 has only two CVCS holdup tanks. The No. 12 tank has been abandoned in place.

The total liquid storage capacity of the three holdup tanks is equal to two RCS volumes. The tanks are constructed of austenitic stainless steel. The cover gas used in these tanks is nitrogen.

Holdup Tank Recirculation Pump

The recirculation pump is used to mix the contents of a holdup tank for sampling or to transfer the contents of a holdup tank to another holdup tank. The wetted surface of this pump is constructed of austenitic stainless steel.

Gas Stripper Feed Pumps

The two gas stripper feed pumps supply feed to the gas stripper-boric acid evaporator train from the holdup tanks. The capacity of each pump is equal to the capacity of a gas stripper-evaporator. The nonoperating pump is a standby and is available for operation in the event the operating pump malfunctions. These canned centrifugal pumps are constructed of austenitic stainless steel.

Evaporator Feed Ion Exchangers

Four flushable evaporator feed ion exchangers remove cations (primarily cesium and lithium) from the holdup tank effluent. Additional ion exchange resin may be used to enhance removal of isotopes such as cobalt.

The design flow rate is equal to the gas stripper-boric acid evaporator processing rate. The demineralizer vessels are constructed of austenitic stainless steel and are provided with suitable connections to facilitate resin replacement when required. The vessels are equipped with resin retention screens.

Ion Exchanger Filters

These filters collect resin fines and particulates from the evaporator feed ion exchangers. The vessels are made of austenitic stainless steel and are provided with connections for draining and venting. Disposable synthetic filter elements in a cage assembly are used. The maximum design flow capacity is equal to the boric acid evaporator flow rate.

Gas Stripper - Boric Acid Evaporator Package

One gas stripper-boric acid evaporator package is provided. The package will process 30 gpm of dilute radioactive boric acid and produce distillate and approximately 12 weight percent of concentrated boric acid, both stripped of the radioactive gases. Radioactive gas stripping is achieved by passing heated feed through packed towers employing stripping steam which removes nitrogen, hydrogen and fission gases from the feed and is designed to reduce the influent gas concentration by a factor of 10^5.

After stripping, the feed enters the evaporator where it is evaporated by a submerged steam tube bundle. The vapors leaving the boiling pool are stripped of entrained liquid and volatile boron by passing through an absorption tower. Pure vapors are then condensed in the condenser section and pumped from the system. When the desired concentration is reached in the boiling pool, the concentrates are pumped from the system. The solids decontamination factor between the condensate and bottoms is approximately 10^6. All evaporator equipment is constructed of austenitic stainless steel.

A boric acid solution is fed from the holdup tanks through the ion exchangers to the gas stripper evaporator packages at a temperature of 50 to 130°F. The feed then passes through a heat exchanger where condensing steam raises its temperature to about 215°F. The feed then passes into the top of the stripping column. Radioactive and other gases are stripped off as the feed passes over the packing in the tower. After stripping, the feed is introduced into the evaporator as makeup. Radioactive gases and other noncondensables are discharged from the system into the waste disposal vent header.

Heating for the evaporator is provided by steam in a submerged tube bundle. Steam to the feed preheater is taken from the same system. A constant vapor pressure is maintained in the evaporator by a pressure control valve on the steam supply line.

A cooling water supply for condensing the distillate is passed through a tube bundle in the condenser.

Some of the distillate produced in the evaporator passes through the absorption tower. This reduces ionic carryover and volatile boron carryover to less than 10 ppm. Condensed distillate is pumped from the system by a distillate pump. Conductivity measurement causes an automatic dump system to return contaminated distillate to the evaporator. Distillate is cooled to 120°F by passing through the distillate cooler heat exchanger.

The concentration of boric acid is determined by sampling and chemical analysis. The boric acid concentrates' pump continuously draws a concentrated solution from the evaporator and through use of hand valves the operator can either return the concentrates to the evaporator or pump it to the concentrates' holding tank. A concentrate sample connection is provided at the discharge of the boric acid concentrates' pump.

The operating output of the system can be adjusted by manual (board mounted control) positioning of the distillate condenser flow control valve. Adjustment of cooling water flow controls the temperature/pressure of condensing distillate in the vapor section of the evaporator. Vapor temperature automatically controls steam input to the submerged tube heating bundle. Thus when the operator manually increases cooling water flow, the vapor temperature is lowered and the steam flow control valve automatically opens to compensate and maintain vapor temperature at the setpoint. When equilibrium is again reached, the overall operating output of the system is increased. Other control circuits such as concentrate level, feed temperature, distillate level, etc., will automatically follow the system conditions and maintain their setpoint.

In case of a low evaporator level caused by feed failure, etc. an alarm will sound; the operator can open a manual distillate return valve which will return all distillate produced to the evaporator.

This coupled with manual return of the blowdown will stop any loss of liquid or vapor from the system until level is returned to normal.

A low temperature in the evaporator, caused by failure of the automatic steam control valve, etc., would sound an alarm on the panel and the operator can open a manual steam bypass valve to raise the temperature.

All lines and miscellaneous equipment in the system containing concentrated boric acid are electric heat traced to prevent boric acid precipitation at low temperatures. Plant Drawings 205229 and 205329 show two lines discharging from the Boric Acid Evaporator. The lines which are heat traced transfers the evaporator bottoms to the Concentrates Holding Tank. This line is heat traced due to high boron concentrates (21000 ppm). The line which is not heat traced is used as the stripping medium in the Gas Stripper. The line runs from the evaporator overhead (steam) and enters the bottom of the packed stripping column of the Gas Stripper. The steam contains low boron concentrates approximately 100 ppm). Heat tracing is therefore not necessary.

The batching tank has a steam jacket to heat the boric acid solution. The source of steam heating for the batching tank is from the house heating boilers and/or one of the main turbines, either of which has a capacity of 140,000 lbs/hr. The batching tank steam jacket requires only 150 lbs/hr. The design, materials, testing and inspection of the batching tank are in accordance with the ASME Boiler and Pressure Vessel Code, Section VIII.

Evaporator Distillate Demineralizers

Two anion demineralizers remove any boric acid contained in the evaporator distillate. Hydroxyl based ion-exchange resin is used to produce evaporator distillate of high purity by releasing a hydroxyl ion when a borate ion is absorbed. Facilities are

provided for regeneration of the resin. When regeneration is no longer feasible, the resin is flushed to the spent resin storage tank. Each demineralizer is sized for a flow rate equal to the evaporator flow rate. The demineralizer vessel is made of all-welded austenitic stainless steel and is equipped with a resin retention screen.

Distillate Filter

The filter collects resin fines and particulates from the boric acid evaporator condensate stream. The vessel is made of austenitic stainless steel and is provided with connections for draining and venting. Disposable synthetic filter elements in a cage assembly are used. The design flow capacity of the filter is equal to the total installed gas stripper-boric acid evaporator flow rate.

Monitor Tanks

Two monitor tanks permit continuous operation of the evaporator train. When one tank is filled, the contents are analyzed and either reprocessed, discharged to the WDS.

Each of the tanks has sufficient capacity to hold the condensate produced during 12 hours of operation from an evaporator at full output.

The tank is vented to the Auxiliary Building atmosphere.

Monitor Tank Pumps

Two monitor tank pumps discharge water from the monitor tanks. Each pump is sized to empty a monitor tank in approximately 3 hours. The pumps are constructed of austenitic stainless steel.

Deborating Demineralizers

When required, two anion demineralizers may be used to remove boric acid from the RCS fluid. The demineralizers are provided for use near the end of a core cycle, but can be used at any time when boron concentration is low. These demineralizers may also be used in a fashion similar to the mixed bed demineralizers, or for lithium removal similar to the cation bed demineralizer when boric acid removal is not required.

Hydroxyl based ion-exchange resin is used to reduce RCS boron concentration by releasing hydroxyl ion when a borate ion is absorbed. Facilities are provided for regeneration. When required, the resin is flushed to the spent resin storage tank.

Each demineralizer is sized to remove the quantity of boric acid that must be removed from the RCS to maintain full power operation near the end of core life should the holdup tanks be full.

Concentrates Filter

A disposable synthetic cartridge-type filter removes particulates from the evaporator concentrates. Design flow capacity of the filter can accommodate the total installed boric acid evaporator capacity. The vessel is provided with connections for draining and venting. Disposable synthetic filter elements in a cage assembly are used.

Concentrates' Holding Tank

The concentrates' holding tank is sized to hold approximately the production of concentrates from one batch from the evaporator. The tank is supplied with an electrical heater which prevents boric acid precipitation.

Concentrates' Holding Tank Transfer Pump

Two holding tank transfer pumps discharge boric acid solution from the concentrates' holding tank to the boric acid tanks. The canned centrifugal pumps are sized to approximately match the capacity of the boric acid evaporator concentrates' pumps or to pump out the contents of the tank in approximately 1 hour. The wetted surfaces are constructed of austenitic stainless steel.

Electrical Heat Tracing

Boric Acid Storage System heat tracing is no longer required due to the reduction in boric acid concentration to between 3.75 and 4.0 weight percent. Boric acid evaporator and concentrates system heat trace is required since these systems will be concentrated to approximately 12 weight percent boric acid.

Valves

Valves that perform a modulating function are equipped with two sets of packing and an intermediate leakoff connection that discharge to the WDS. Valves are normally installed such that, when closed, pressure is not on the packing. Basic material of construction is stainless steel for all valves.

Isolation valves are provided for all connections to the RCS. Lines entering the reactor containment also have check valves inside the containment to prevent reverse flow from the containment.

Relief valves are provided for lines and components that might be pressurized above design pressure by improper operation or component malfunction. Pressure relief for the tube side of the regenerative heat exchanger is provided by a locked open manual isolation valve and a 250 psi spring-loaded check valve bypassing the charging isolation valves. The Volume Control Tank relief path contains administratively controlled manual isolation valves between the relief valve and the Holdup Tanks. ASME Section III Code relief was obtained for the Volume Control Tank and regenerative heat exchanger relief systems using administrative controls per NRC approval (Section 9.7.3, Reference 3).

Piping

All CVCS piping handling 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.

Primary Water Storage Tank

The tank is provided with a high level alarm and the overflow line is piped to the diked area around the No. 13 chemical and volume control holdup tank, from where any overflow can be pumped to the Liquid Waste Disposal System. The overflow line includes a collection pot which is also provided with a high level alarm. Both alarms are indicated in the Control Room.

9.3.4.3 System Design Evaluation

9.3.4.3.1 Availability and Reliability

A high degree of functional reliability is assured in the CVCS by providing standby components where performance is vital to safety and by assuring fail-safe response to the most probable mode of failure. Special provisions include duplicate heat tracing with alarm protection of lines, valves, and components normally containing concentrated boric acid and required for boric acid control.

The CVCS has three high pressure charging pumps, which are capable of supplying the required reactor coolant pump seal and makeup flow.

Aside from those components that are also part of the ECCS (Section 6), the CVCS is not required to function during a LOCA.

The generation of a safety injection signal automatically closes the motor-operated valves in the outlet line of the volume control

tank and in the normal charging line thus isolating the CVCS from the safety injection path. The letdown line and reactor coolant pump seal water return line are isolated at the containment boundary by a valve which automatically closes as a result of high containment pressure caused by a LOCA. The centrifugal charging pumps are also automatically started and commence pumping into the RCS immediately.

9.3.4.3.2 Control of Tritium

The CVCS is also used to control the concentration of tritium in the RCS. Essentially all of the tritium is in chemical combination with oxygen as a form of water. Therefore, any leakage of coolant to the containment atmosphere carries tritium in the same proportion as it exists in the coolant. Thus, the level of tritium in the containment atmosphere, when it is sealed from outside air ventilation, is a function of tritium level in the reactor coolant, the dewpoint temperature of the air, and the presence of leakage other than reactor coolant as a source of moisture in the containment air.

There are two major considerations with regard to the presence of tritium in the reactor coolant:

1. Possible plant personnel hazard during access to the containment must be limited. Leakage of reactor coolant during operation with a closed containment causes an accumulation of tritium in the containment atmosphere.

2. Undue public hazard due to release of tritium to the plant environment must be avoided.

Both of these criteria are met in this plant. The concentration of tritium in the reactor coolant is maintained at a level which precludes personnel hazard during access to the containment. This can be achieved by discharging part of the distillate from the primary water recovery process to the WDS (Section 11).

Essentially all of the tritium in the reactor coolant will eventually be released via the Radwaste System (Section 11) to the plant discharge stream. In the plant discharge stream, the tritium (and other liquid radwastes) is mixed with the plant effluent water flow.

9.3.4.3.3 Leakage Provisions

Quality control of the material and installation of the CVCS valves and piping which are designated for radioactive service is provided, in order to essentially eliminate leakage to the atmosphere.

The components designated for radioactive service are provided with welded connections to prevent leakage to the atmosphere. However, flanged connections are provided on each charging pump suction and discharge, on each boric acid pump suction and discharge, on the relief valves' inlet and outlet, on three-way valves and on the flow meters to permit removal for maintenance.

The positive displacement charging pump stuffing box is provided with a leakoff to collect reactor coolant. All valves which are larger than 2 inches and which are designated for radioactive service at an operating fluid temperature normally above 212°F are provided with a stuffing box and lantern leakoff connections. All control valves are either provided with stuffing box and leakoff connections or are totally enclosed.

Diaphragm valves are provided where the operating pressure is 200 psi or below and the operating temperature is 200°F or below.

9.3.4.3.4 Incident Control

The letdown line and the reactor coolant pumps' seal water return line penetrate the reactor containment. The letdown line contains three air-operated valves inside the reactor containment and one air-operated valve outside the reactor containment which are automatically closed by the containment isolation signal. The reactor coolant pumps' seal water return line contains one motor-operated isolation valve outside the reactor containment and one motor-operated valve inside the containment which are automatically closed by the containment isolation signal.

The four seal water injection lines to the reactor coolant pumps and the charging line are inflow lines penetrating the reactor containment. Each line contains a check valve inside the reactor containment to provide isolation of the reactor containment should a break occur in these lines outside the reactor containment.

In the event of an accidental release of radioactivity in the area housing the CVCS, personnel safety equipment is available and will be used to protect operating personnel. For example, equipment such as respirators, appropriate protective clothing, and radiation survey meters would be used to guard against inhalation of possible airborne activity, personnel contamination, and exposure to possibly high radiation levels. Immediately after the accidental release of a radioactive source, entry into the building housing the CVCS will be through an access control point under the supervision of health physics trained personnel. The required equipment, outlined above, will be available in the vicinity of the control point. This area also contains a monitoring and clothing change area, a personnel decontamination washroom and showers, and a first aid room.

Radiation levels outside of a shielded compartment where such a release has occurred will not be severely affected. The dose rates outside the shield wall could rise from 2.5 mR/hr to approximately 4.0 mR/hr until cleanup procedures have been

initiated. This higher dose rate is based on a leak large enough to result in all inner compartment surfaces being covered with radioactive liquid, and that the excess liquid that drains from the surfaces runs into the floor drains. The liquid activity is assumed to be that associated with 1 percent failed fuel. If the excess liquid did not flow into the floor drains and was contained within the compartment, the dose rate outside the shield wall could rise to approximately 25 mR/hr.

If a demineralizer ruptured releasing all its resin into the shielded compartment, the dose rates outside the compartment would not be significantly affected since each demineralizer tank is in a cell which is completely isolated from personnel and separated from the operating aisle by a valve gallery shield wall. Further, no credit for the thickness of the demineralizer wall was taken in the design of the concrete shield wall.

9.3.4.3.5 Malfunction Analysis

To evaluate system safety, failures or malfunctions were assumed concurrent with a LOCA, and the consequences analyzed (see Table 9.3-7 and Section 15).

If a rupture takes place between the reactor coolant loop and the first isolation valve or check valve, an uncontrolled loss of reactor coolant occurs. The analysis of the LOCA is discussed in Section 15.

Should a rupture occur in the CVCS outside the containment, or at any point beyond the first check valve or remotely operated isolation valve, actuation of the valve would limit the release of coolant and assure continued functioning of the normal means of heat dissipation from the core. For the general case of rupture in the CVCS outside the containment, the largest source of radioactive gases and fluid subject to release is the contents of the volume control tank. The consequences of such a release are considered in Section 15.

When the reactor is subcritical, i.e., during cold or hot shutdown, refueling and approach to criticality, the relative reactivity status (neutron source multiplication) is continuously monitored and indicated by BF_3 counters and count rate indicators. 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 corrective action (boron dilution stop and emergency boron injection) to prevent the core from becoming critical. This case is analyzed in Section 15.

At least two separate and independent flow paths are available for reactor coolant boration; i.e., the charging line, or the high head safety injection, BIT cold leg flow path. The malfunction or failure of one component does not result in the inability to borate the RCS. An alternate flow path is always available for emergency boration of the reactor coolant. As backup to the Boration System, the operator can align the refueling water storage tank outlet to the suction of the charging pumps.

Boration during operation to compensate for power changes will be indicated to the operator from a combination of two sources: 1) the control rod movement and 2) the flow indicator in the boric acid transfer pump discharge line. When the emergency boration path is used, four indications to the operator are available. The primary indication is a flow indicator in the emergency boration line. The charging line flow indicator will indicate boric acid flow since the charging pump suction is aligned to the boric acid transfer pump suction for this mode of operation. The change in boric acid tank level and control rod motion are other indications of boric acid injection.

On loss of seal injection water to the reactor coolant pump seals, seal water flow may be re-established by starting a standby charging pump. If all the unit's charging pumps are lost, seal injection can be re-established using the cross-tie from the opposite unit. Short-term actions re-align the charging suction header to the RWST in the opposite unit and the normally shut cross-tie discharge isolation valve, which is remote/manual MOV, is opened from the Control Room to minimize the time delay.

During plant operation without seal injection flow, the thermal barrier cooler serves to cool the reactor coolant flow that passes through the thermal barrier cooler, thereby controlling the No. 1 seal leak-off temperature. However, studies have shown that with an initial seal leak-off flow <2.5 gpm, seal leak-off temperature limits could be exceeded unless seal injection is restored. In the event seal water injection flow cannot be re-established prior to the reactor coolant pump No. 1 seal leak-off temperatures exceeding the alarm setpoint, the affected reactor coolant pump will be stopped and plant will be shutdown, as required.

It can be concluded that proper consideration has been given to station safety in the design of the system.

9.3.4.3.6 Galvanic Corrosion

The only types of materials which are in contact with each other in borated water are stainless steels, Inconel, Stellite valve materials and Zircaloy fuel element cladding. Those materials have been shown to exhibit only an insignificant degree of galvanic corrosion when coupled to each other.

For example, the galvanic corrosion of Inconel versus 304 stainless steel resulting from high temperature tests (575°F) in lithiated, boric acid solution was found to be less than $-20.9\ mg/dm^2$ for the test period of 9 days. Further galvanic corrosion would be trivial since the cell currents at the conclusion of the tests were approaching polarization. Zircaloy versus 304 stainless steel was shown to polarize at 180°F in lithiated, boric acid solution in less than 8 days with a total galvanic attack of $-3.0\ gm/dm^2$. Stellite versus 304 stainless steel was polarized in 7 days at 575°F in lithiated boric acid solution. The total galvanic corrosion for this couple was $-0.97\ gm/dm^2$.

As can be seen from the tests, the effects of galvanic corrosion are insignificant to systems containing borated water.

9.3.4.4 Tests and Inspections

Those portions of the CVCS associated with the Emergency Core Cooling System will be subject to the same type of inspections required for those systems as outlined in Section 6. Special tests and inspections for the remainder of the CVCS are not required

because the system is in daily operation. Routine maintenance during refueling can be performed on system components.

The contents of the boric acid tanks will be sampled at least once per week to assure required boric acid concentrations.

9.3.5 Failed Fuel Detection System

9.3.5.1 Design Basis

The Gross Failed Fuel Detection System consists of equipment designed to indicate gross fuel failure by monitoring the delayed neutron activity in the reactor coolant.

9.3.5.2 System Description

The gross failed fuel detector is connected to the hot leg of a primary coolant loop (Figure 9.3-9). The coolant sample passes through a cooler and then into a coil encompassing a neutron detector and moderator, then to a connection upstream of the mixed bed demineralizers after which it flows back into the volume control tank. The delay time depends on the length of tubing used. A transmitting flowmeter is installed for periodic checks of the flow rate. A sensor monitors the sample cooler outlet temperature.

Figure 9.3-10 shows the block diagram of the gross failed fuel detector channel. The detector, preamp, sample coolers, and associated flow indication 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.

9.3.5.3 Safety Evaluation

The Gross Failed Fuel Detection System does not perform a safety-related function, and is not designed to satisfy any specific safety criteria. As shown on Figure 9.3-9, the gross failed fuel detector is outside of the containment and is installed in the primary coolant hot leg sample line. It is isolated from the containment by means of the Sampling System isolation valves. The safety evaluation of the Sampling System, including the isolation valves, is discussed in Section 9.3.2.

A confirmatory radiochemical analysis for failed fuel in the primary system would be performed and would require approximately 1 1/2 hours of sampling, preparation, counting and calculations. In the event that personnel to perform analysis are not onsite, an additional 2 hours will be required for notification and travel time.

The system measures gamma radiation in a continuously flowing sample of primary coolant. It is designed to monitor the coolant for gross gamma activity. This is accomplished by using a gamma scintillation detector.

In addition to continuous indication of the reactor coolant activity, abnormal conditions are alarmed in the Control Room.

The Unit 1 detector is capable of measuring up to 1×10^{6} cpm. The Unit 2 detector is capable of measuring up to 1×10^{9} cpm. Provision is made for desensitizing the system by two or more decades to compensate for permanent activity buildup resulting from long-term normal operation. This is accomplished by insertion of a lead spacer between the sensitive end of the detector and the letdown line.

With the plant operating with reactor coolant activity corresponding to one percent failed fuel, the concentration of all isotopes in the coolant will be about 226 μCi/cc.

Assuming that "gross" fuel failure has occurred, the action that would be taken is a function of both the magnitude of reactor coolant activity and the rate of change. For the case where activity is higher than previous values, but below Technical Specification limits, the following action would be taken:

1. Increase purification flow to maximum.

2. Calculate coolant activity in μCi/cc and new E if greater than predetermined change in activity has occurred.

3. Increase sampling frequency to a minimum of once per day until trends are clearly established.

4. If coolant activity is increasing and approaching Technical Specification limits, reduce power and attempt to establish equilibrium.

5. Verify reactor power distribution to assure that rod patterns and flux shapes are within normal values.

In the event that coolant activity is increasing rapidly to the Technical Specification limit or has reached that limit, the plant would be shut down and cooled to 500°F or less.

The above actions would be initiated promptly following confirmatory radiochemical analysis. Most of these actions can be initiated upon receipt of the failed fuel alarm, except for trending, which will require several samples.

In the event the Failed Fuel Monitoring System is inoperable while the reactor is critical, the RCS will be analyzed for dose equivalent I-131 five days per week with not longer than 72 hours between sampling intervals.

9.3.5.4 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.

9.3.5.5 Instrument Applications

Instrumentation associated with the Gross Failed Fuel Detection System is described in Section 9.3.5.2.

9.3.6 Post Accident Sampling System

The eight PASS sample and return lines for Salem Units 1 and 2 have been cut and capped on both sides of the applicable containment penetration. The RCS sample lines were also cut and capped at the connection point to the sample system tubing.

9.3.6.1 Design Basis

License Amendments 254/235 removed the Post Accident Sampling System from the license base for Salem Units 1 & 2. NRC approval of PASS elimination was based on the following contingencies:

- PSEG has developed contingency plans for obtaining and analyzing highly radioactive samples of RCS, containment sump and containment atmosphere.

- PSEG has verified that it has the capability for classifying fuel damage events at the alert level threshold and has committed to maintain the capability for the alert classification in plant implementing procedures.

- PSEG has verified that it has the capability to monitor radioactive iodines that have been released to offsite environs and has committed to maintain the capability for monitoring iodines in plant implementing procedures.

Subsequent text regarding PASS is maintained for historical purposes.

The functional and design requirements for the Post Accident Sampling System (PASS) are contained in NUREG-0737, Item II.B.3 and in Regulatory Guide 1.97. The seismic design and quality group classification of the PASS sampling lines and components conform to the classification of the system to which each sampling line is connected. Seismic design and quality group classification for components and piping downstream of the second isolation valve in the PASS conform to NUREG-0737 requirements. Additionally, the ventilation exhaust is filtered with high-efficiency particulate (HEPA) filters. Section 9.4.2 describes Auxiliary Building Ventilation filtering modes. PASS ventilation exhaust is not aligned to the charcoal adsorbers during emergency plant operations.

The PASS provides the capability to obtain, under accident conditions, a containment air grab sample, liquid and stripped gas reactor coolant grab samples (diluted and undiluted) and to perform various analyses using inline instrumentation. Grab samples are used to determine isotopic and hydrogen concentrations in containment air, and isotopic, boron, pH, chloride and hydrogen concentrations in reactor coolant. The inline instrumentation provides analysis of dissolved hydrogen, dissolved oxygen, chlorides, boron, conductivity and pH for reactor coolant. Acquisition and analysis of these samples can be performed in a manner which limits radiation exposure to personnel to 5 rem/year whole body and 75 rem/year to the extremities.

9.3.6.2 System Description

Sample Lines and Sample Points

Two redundant sample loops are utilized per unit (two separate channels). Reactor coolant sample lines connect into the Nos. 11, 13, 21, and 23 hot legs. Sample return lines are routed to the containment sump.

Containment atmosphere samples are tied into the Radiation Monitoring System sample supply lines. Samples are returned to the containment.

Sample lines are designed to minimize crud traps and dead legs. The lines are separated to provide assurance that a single pipe break will not render both loops inoperative.

Penetrations are cooled with compressed air to limit the temperature of the containment wall surrounding the penetrations from exceeding 150°F.

Shielding is provided on the Unit 1 sampling lines where the lines cross the access corridors on the 100-foot elevation of the Auxiliary Building. All other sampling lines pass through shielded areas of the Auxiliary Building. Where feasible, lines are run along floors to facilitate the use of lead blankets should the need arise.

Analysis Equipment

The following PASS equipment processes the reactor coolant and containment air samples.

The Liquid Sampling Panel (LSP) routes reactor coolant samples to the Chemical Analysis Panel (CAP) for online gas and liquid analysis.

The LSP also captures gases stripped from pressurized reactor coolant for hydrogen and isotopic analysis; depressurized, reactor coolant for pH and isotopic analysis; and depressurized, diluted reactor coolant for boron, chloride, and isotopic analysis.

The CAP provides the capability for online determination of the pH, specific conductivity, oxygen content, and chloride content of a liquid sample. In addition, the gas chromatograph permits determination of the hydrogen content of the gas stripped from the reactor coolant.

The containment air sampling panel (CASP) collects grab samples.

The CASP control panel is used to select, start and monitor the CASP sample exercises. Once the operator has started the CASP, a programmer automatically performs the exercise.

Both the CASP control panel and the CAP monitor panel are separated from the LSP, CASP, and CAP by shielding to minimize operator exposure while operating the equipment.

The shielding in the panels limits the maximum dose from the panel to an operator in accordance with sampling exercise to 100 mrem.

Analytical equipment for isotopic analysis is located in the Counting Room on the 100-foot elevation on the Unit 2 side of the Auxiliary Building. Sample preparation and boron analysis equipment are located in the Chemistry Lab on the 100-foot elevation on the Unit 1 side of the Auxiliary Building. This equipment serves both Units 1 and 2.

The Sampling Room cooler maintains an environment that is satisfactory for both personnel and equipment operation.

Analysis equipment is not seismically qualified.

Interfaces

Piping connections to other fluid systems are designed consistent with the safety class and seismic category of the interfacing system. In particular, interfaces with non-seismic portions are designed in such a way that failure of non-seismic portions of the PASS will not degrade the interfacing system performance.

Ten gallons per minute of component cooling water is supplied to the sample cooler rack to cool reactor coolant samples.

Redundant control air is provided for pneumatic operation of the containment isolation valves.

Demineralized water is provided for flushing the sample lines and analysis equipment after a sampling operation.

Nitrogen is provided for purging the containment air sampling lines and for the nitrogen-operated eductor which induces the flow of air from the containment to the CASP and back to containment.

9.3.6.3 Design Evaluation

Electric power is supplied from the 1E vital bus. Heat tracing is supplied with redundant power. Consequently the PASS is expected to remain operable during accidents concurrent with loss of offsite power. The PASS is not designed to operate following certain single failures, e.g., failure of sampling analysis equipment.

9.3.7 Reference for Section 9.3

1. Sammarone, D. G., "The Galvanic Behavior of Materials in Reactor Coolants," WCAP-1844, August 1961.

2. ABB Report "Boric Acid Concentration Reduction Effort" CEN-606, Revision 00, Technical Bases and Operational Analysis for Salem Nuclear Generating Station Units 1 and 2.

3. NRC Letter from J.F. Stolz (NRC) to L.R. Eliason (PSE&G), "Salem Nuclear Generating Station Unit No.s 1 and 2 Section III Relief Request," November 6, 1995.

TABLE 9.3-1

SAMPLING SYSTEM CODE REQUIREMENTS

Primary sample heat exchanger	ASME Boiler and Pressure Vessel Code, Section VIII, Unfired Pressure Vessels, Div. I
Sample pressure vessels	ASME Boiler and Pressure Vessel Code, Section VIII, Unfired Pressure Vessels, Div. I
Piping and valves	ANSI B31.1.0* ANSI B31.7**
Steam generator blowdown sample and steam sample heat exchangers	ASME Boiler and Pressure Vessel Code, Section VIII, Unfired Pressure Vessels, Div. I

* ANSI B31.1.0 - Code for Power Piping, used for design.

** For piping not supplied by the NSSS supplier, material inspection, fabrication, and quality control conform to ANSI B31.7. Where not possible to comply with ANSI B31.7, the requirements of ASME III-1971, which incorporated ANSI B31.7, were adhered to.

TABLE 9.3-2

SAMPLING SYSTEM COMPONENTS

Primary System Sampling Heat Exchanger

General

Number	3	
Type	Shell and coiled tube	
	Shell	Tube
Design pressure, psig	150	2485
Design temperature, °F	350	680
Design flow, gpm	14.1	0.42
Temperature, in, °F	95	652.7 (max)
Temperature, out, °F	125	127 (max)
Material	Carbon steel	Austenitic Stainless Steel
Fluid	Component cooling water	Sample

Steam Generator Blowdown Sampling Heat Exchanger

General

Number	8	
Type	Shell and coiled tube	
	Shell	Tube
Design pressure, psig	150	1500
Design temperature, °F	650	550
Design flow, gpm	6	0.40
Temperature, in, °F	95	550 (max)
Temperature, out, °F	125	127 (max)
Material	Carbon steel	Austenitic Stainless Steel
Fluid	Component cooling water	Sample

Sample Pressure Vessels

Number, total	1
Volume, ml	75
Design pressure, psig	2485
Design temperature, °F	680
Material	Austenitic Stainless Steel

Piping

Design pressure, psig	2485
Design temperature, °F	680

TABLE 9.3-3

MALFUNCTION ANALYSIS OF SAMPLING SYSTEM

Component	Malfunction or Failure	Consequence
Pressurizer Sample Lines or Reactor Coolant Sample Lines	An isolation valve fails to close on containment isolation signal	The second isolation valve closes on containment isolation signal, maintaining containment integrity
Any of the above Sample Lines	Break in line downstream of isolation valves	Isolation valves close on containment isolation signal
Sample Heat Exchangers	Loss of cooling water	Sample lines can be isolated at the containment. Cooling of samples is not required

TABLE 9.3-4

CHEMICAL AND VOLUME CONTROL SYSTEM CODE REQUIREMENTS

Regenerative heat exchanger	ASME III*, Class C
Letdown heat exchanger	ASME III, Class C, Tube Side, ASME VIII, Shell Side
Mixed bed demineralizers	ASME III, Class C
Reactor coolant filter	ASME III, Class C
Volume control tank	ASME III, Class C
Seal water heat exchanger	ASME III, Class C, Tube Side, ASME VIII, Shell Side
Excess letdown heat exchanger	ASME III, Class C, Tube Side, ASME VIII, Shell Side
Cation bed demineralizer	ASME III, Class C
Seal water injection filters	ASME III, Class C
Boric acid filter	ASME III, Class C
Evaporator condensate demineralizers	ASME III, Class C
Concentrates filter	ASME III, Class C
Evaporator feed ion exchangers	ASME III, Class C
Ion exchanger filter	ASME III, Class C
Condensate filter	ASME III, Class C
Piping and valves	ANSI B31.1** ANSI B31.7*** ****

* ASME III - American Society of Mechanical Engineers, Boiler and Pressure Vessel Code, Section III, Nuclear Vessels.

** ANSI B31.1 - Code for Power Piping, used for design.

*** For piping not supplied by the NSSS supplier, material inspection, fabrication, and quality control conform to ANSI B31.7. Where not possible to comply with ANSI B31.7, the requirements of ASME III-1971, which incorporated ANSI B31.7, were adhered to.

**** ASME Section III Code relief was obtained for the Volume Control Tank and regenerative heat exchanger relief systems using administrative controls per NRC approval (Section 9.3.7, Reference 3).

TABLE 9.3-5

CHEMICAL AND VOLUME CONTROL SYSTEM
DESIGN PARAMETERS

General

Plant design life, years	40
Seal water supply flow rate:	
Normal, gpm	32
Maximum, gpm	113
Seal water return flow rates:	
Normal, gpm	12
Maximum, gpm	93
Letdown flow:	
Normal, gpm	75
Minimum, gpm	45
Maximum, gpm	120
Charging flow:	
Normal, gpm	55
Minimum, gpm	25
Maximum, gpm	100
Temperature of letdown reactor coolant entering system at full power, □F	542.7
Centrifugal pump miniflow, gpm	60 (each)
Normal temperature of charging flow directed to Reactor Coolant System, □F	495
Temperature of effluent directed to holdup tanks, □F	127

(Volumetric flow rates in gpm are nominal values based upon 130 □F and 2350 psig)

TABLE 9.3-6

PRINCIPAL COMPONENT DATA SUMMARY

Regenerative Heat Exchanger

Number	1
Heat transfer rate at design conditions, Btu/hr	10.28×10^{6}

Shell Side

Design pressure, psig	2485
Design temperature, °F	650
Fluid	Borated reactor coolant
Material of construction	Austenitic stainless steel

	Normal (Design)	Maximum Purification	Heatup
Flow, lb/hr	37,050	59,280	59,280
Inlet temperature, °F	555	542.7	542.7
Outlet temperature, °F	298	294	369

Tube Side

Design pressure, psig	2825*
Design temperature, °F	650
Fluid	Borated reactor coolant
Material of construction	Austenitic stainless steel

	Normal (Design)	Maximum Purification	Heatup
Flow, lb/hr	27,170	49,400	29,640
Inlet temperature, °F	130	130	130
Outlet temperature, °F	495	466	520

Letdown Orifice

Design pressure, psig	2485
Design temperature, °F	650
Normal operating inlet pressure, psig	2185
Normal operating temperature, °F	290
Material of construction	Austenitic stainless steel

	45 gpm	75 gpm
Number	1	2
Design flow, lb/hr	22,230	27,050
Differential pressure at design flow, psig	1900	1900

* Associated pipe design pressure for Pipe Schedule SPS48B is 2825 psig, based on CV141 setpoint pressure. Per the design code, maximum allowable accumulation for pressure relief is 110% of ASME pressure vessel design pressure (Reference Calculation S-C-CVC-MDC-2348).

TABLE 9.3-6 (Cont)

Letdown Heat Exchanger

Number	1
Heat transfer rate at design conditions (heatup), Btu/hr	14.8×10^6

Shell Side

Design pressure, psig	150
Design temperature, °F	250
Fluid	Component cooling water
Material of construction	Carbon steel

	Normal	Heatup (Design)	Maximum Purification
Flow, lb/hr	203,000	492,000	320,000
Inlet temperature, °F	95	95	95
Outlet temperature, °F	125	125	125

Tube Side

Design pressure, psig	600
Design temperature, °F	400
Fluid	Borated reactor coolant
Material of construction	Austenitic stainless steel

	Normal	Heatup (Design)	Maximum Purification
Flow, lb/hr	37,050	59,280	59,280**
Inlet temperature, °F	290	380 (max)	380 (max)
Outlet temperature, °F	127	127	127

Mixed Bed Demineralizers

Number	2
Type	Flushable
Vessel design pressure:	
Internal, psig	200
External, psig	15
Vessel design temperature, °F	250
Resin volume, each, ft^3	30
Vessel volume, each, ft^3	43
Design flow rate, gpm	120*
Minimum decontamination factor	10
Normal operating temperature, °F	127
Normal operating pressure, psig	150
Resin type	Cation, anion, or application-specific
Material of construction	Austenitic stainless steel

* Qualified for 180gpm during Low Pressure RHR Letdown operation (Ref. VTD 328295, sht. 002)

** Qualified for 88650 lb/hr during Low Pressure RHR Letdown operation (Ref. VTD 328295, sht. 002)

TABLE 9.3-6 (Cont)

Resin Fill Tank

Number	1
Capacity, ft^3	8
Design pressure	Atmospheric
Design temperature, °F	200
Normal operating temperature	Ambient
Material of construction	Austenitic stainless steel

Reactor Coolant Filter

Number	1
Type	Replaceable assembly
Design pressure, psig	200
Design temperature, °F	250
Flow rate:	
Nominal, gpm	120
Maximum, gpm	150*
Material of construction	Austenitic stainless steel
Filtration Requirement	≥98 Percent retention of particles above 25 micron

Volume Control Tank

Number	1
Internal volume, ft^3	400
Design pressure:	
Internal, psig	75
External, psig	15
Design temperature, °F	250
Operating pressure range, psig	0 - 60
Normal operating pressure, psig	15
Spray nozzle flow (maximum), gpm	120*
Material of construction	Austenitic stainless steel

Centrifugal Charging Pumps

Number	2
Type	Horizontal centrifugal
Design pressure, psig	2800
Design temperature, °F	300
Shutoff head, psi	2670
Normal suction temperature, °F	127
Design flowrate, gpm	150
Design head, ft	5800
Required NPSH at 150 gpm, ft	10
Material	Austenitic stainless steel

* Qualified for 180gpm during Low Pressure RHR Letdown operation (Ref. VTD 328295, sht. 002)

Positive Displacement Charging Pump

Number	1
Type	Positive displacement with variable speed drive
Design head, ft	5800
Design temperature, °F	250
Design pressure, psig	3200
Design flow rate*, gpm	98
Suction temperature, °F	127
Discharge pressure at 130°F, psig	2500
Material of construction	Austenitic stainless steel
Maximum operating pressure, psia	3125

Chemical Mixing Tank

Number	1
Capacity, gal	5
Design pressure, psig	150
Design temperature, °F	200
Normal operating temperature	Ambient
Material of construction	Austenitic stainless steel

Boric Acid Tank

Number	2
Capacity (each), gal	8000
Design pressure	Atmospheric
Design temperature, °F	250
Normal operating temperature, °F	Ambient
Material of construction	Austenitic stainless steel

Boric Acid Tank Electric Immersion Heater

Number (two per tank)	4
Heat transfer rate, each, kW	7.5
Material of construction	Austenitic stainless steel sheath

Batching Tank and Batching Tank Heater Jacket

Number	1
Type	Cylindrical with steam panel coils
Capacity, gal	400
Design pressure	Atmospheric
Design temperature, °F	300
Steam temperature, °F	250
Initial ambient temperature, °F	32
Final fluid temperature, °F	>80
Heatup time, hr	≈ 3
Tank material of construction	Austenitic stainless steel
Panel coils, material of construction	Carbon steel

* At 130°F, 2500 psig

Batching Tank Agitator

Number	1
Fluid handled, boric acid, wt percent	12
Service	Continuous
Tank volume, gal	400
Operating temperature, °F	165
Operating pressure	Atmospheric
Material of construction	Austenitic stainless steel

Excess Letdown Heat Exchanger

Number	1	
Heat transfer rate at design conditions, Btu/hr	4.61×10^6	
	Shell Side	Tube Side
Design pressure, psig	150	2485
Design temperature, °F	250	650
Design flow rate, lb/hr	115,000	12,380
Inlet temperature, °F	95	545
Outlet temperature, °F	135	195
Fluid	Component cooling water	Borated reactor coolant
Material of construction	Carbon Steel	Austenitic stainless steel

Seal Water Heat Exchanger

Number	1	
Heat transfer rate at design conditions, Btu/hr	2.49×10^6	
	Shell Side	Tube Side
Design pressure, psig	150	150
Design temperature, °F	250	250
Design flow rate, lb/hr	99,500	160,600
Design operating inlet temperature, °F	95	143
Design operating outlet temperature, °F	120	127
Fluid	Component cooling water	Borated reactor coolant
Material of construction	Carbon steel	Austenitic stainless steel

Seal Water Filter	
Number	1
Type	Replaceable Assembly
Design pressure, psig	200
Design temperature, °F	250
Maximum flow rate, gpm	325
Vessel material of construction	Austenitic stainless steel
Filtration Requirement	98 percent retention of particles above 25 microns
Boric Acid Filter	
Number	1
Type	Replaceable Assembly
Design pressure, psig	200
Design temperature, °F	250
Design flow, gpm	150
Vessel material of construction	Austenitic stainless steel
Filtration Requirement	98 percent retention of particles above 25 microns
Boric Acid Transfer Pump	
Number	2
Type	Two-speed horizontal centrifugal
Design flow rate, each, gpm	75*
Design pressure, psig	150
Design discharge head, ft	235
Design temperature, °F	250
Temperature of pumped fluid, °F	70
Required NPSH at 75 gpm, ft	6
Material of construction	Austenitic stainless steel
Boric Acid Blender	
Number	1
Design pressure, psig	150
Design temperature, °F	250
Material of construction	Austenitic stainless steel
Cation Bed Demineralizer	
Number	1
Type	Flushable
Vessel design pressure:	
Internal, psig	200
External, psig	15
Vessel design temperature, °F	250
Normal operating temperature, °F	127
Normal operating pressure, psig	150
Design flow, gpm	75
Resin type	Cation
Material of construction	Austenitic stainless steel

*Because of the severe duty from pumping boric acid, the minimum required flow, which is verified by the In-Service Testing Program for pumps, has been set as 45 gpm.

Chemical Mixing Tank Orifice

Number	1
Design pressure, psig	150
Design temperature, °F	200
Design flow, gpm	2
Material of construction	Austenitic stainless steel

Boric Acid Tank Orifice

Number	2
Design pressure, psig	150
Design temperature, °F	200
Design flow, gpm	3
Material of construction	Austenitic stainless steel

Deborating Demineralizers

Number	2
Type	Regenerable
Vessel design pressure:	
Internal, psig	200
External, psig	15
Vessel design temperature, °F	250
Normal flow, gpm	127
Normal operating temperature, °F	127
Normal operating pressure, psig	150
Resin type	Cation, anion, or Application-specific
Material of construction	Austenitic stainless steel

Seal Injection Filters

Number	2
Design pressure, psig	2735
Design temperature, °F	200
Design flow, gpm	80
Particle retention	98 percent above 5 micron
Fluid	Reactor coolant containing up to 4.0 weight percent boric acid
Material of construction, vessel	Austenitic stainless steel
Type	Replaceable Assembly

No. 1 Seal Bypass Orifice

Number	4
Design pressure, psig	2485
Design temperature, °F	250
Design flow, gpm	1.0
Differential pressure at design flow, psi	300

Holdup Tanks

Number	*3
Design temperature, °F	200
Design pressure, psig	15
Volume, each, ft^3	8500
Normal operating pressure, psig	3
Normal operating temperature, °F	130
Material of construction	Austenitic stainless steel

Recirculation Pump

Number	1
Type	Centrifugal
Design flow, gpm	500
Design head, ft	100
Design pressure, psig	75
Design temperature, °F	200
Normal operating temperature, °F	115
Material of construction	Austenitic stainless steel

Gas Stripper Feed Pumps

Number	2
Type	Canned
Design flow, gpm	30
Design head (TDH), ft	320
Design pressure, psig	150
Design temperature, °F	200
Normal fluid temperature, °F	115
Material of construction	Austenitic stainless steel

Gas Stripper and Evaporator Package Unit

Number of Units	1
Design flow/unit; gas stripper feed, gpm	30
Evaporator condensate, gpm	30
Evaporator concentrates (batch flow), gpm	40
Decontamination factors (design):	
Gas stripper	Approx 10^5 (for gas)
Evaporator	Approx 10^6 (for liquid)
Concentration of concentrates, boric acid, wt percent	12
Concentration of distillate	<10 ppm boron as H_3BO_3 <0.1 ppm oxygen Conductivity <2.0 μmhos/cm pH = 6.0 to 8.0
Material of construction	Austenitic stainless steel

* Unit No. 1 has only two CVCS Hold-up Tanks. The No. 12 Tank has been abandoned in place.

Evaporator Distillate Demineralizers

Number	2
Type	Regenerable
Design temperature, °F	250
Design pressure:	
Internal, psig	200
External, psig	15
Design flow, gpm	30
Normal operating pressure, psig	50
Normal operating temperature, °F	130
Resin type	Anion
Material of construction	Austenitic stainless steel

Monitor Tanks

Number	2
Volume, each, gal	21,600
Design pressure	Atmospheric
Design temperature, °F	150
Material of construction	Stainless steel

Monitor Tank Pumps

Number	2
Type	Centrifugal
Design flow, gpm	150
Design head, ft	200
Design pressure, psig	150
Design temperature, °F	200
Material of construction	Austenitic stainless steel
NPSH, ft	15

Evaporator Feed Ion Exchangers

Number	4
Type	Flushable
Design temperature, °F	250
Design pressure:	
Internal, psig	200
External, psig	15
Minimum decontamination factor for ions removed	10
Design flow, gpm	30
Normal operating temperature, °F	130
Normal operating pressure, psig	75
Resin type	Cation
Material of construction	Austenitic stainless steel

Concentrates Filter

Number	1
Type	Cage type
Design pressure, psig	200
Design temperature, °F	250
Design flow rate, gpm	35
Retention for 25 micron particles	98 percent
Material of construction (vessel)	Austenitic stainless steel

Concentrates Holding Tank

Number	1
Type	Cylindrical, heated
Volume, gal	1000
Design pressure	Atmospheric
Design temperature, °F	250
Normal operating temperature, °F	150
Material of construction	Austenitic stainless steel

Concentrates Holding Tank Transfer Pump

Number	2
Type	Centrifugal canned
Design flow rate, gpm	40
Design head, ft	150
Design temperature, °F	250
Design pressure, psig	100
Required NPSH at 40 gpm, ft	8
Material of construction	Austenitic stainless steel

Concentrates Holding Tank Electric Heater

Number	1
Heat transfer rate, kW	3.0
Material of construction	Austenitic stainless steel

Ion Exchanger Filter

Number	1
Type	Cage assembly
Design pressure, psig	200
Design temperature, °F	250
Design flow rate, gpm	35
Retention of 25 micron particles	98 percent
Material of construction	Austenitic stainless steel

Table 9.3-6 (Cont)

Distillate Filter

Number	1
Type	Cage assembly
Design pressure, psig	200
Design temperature, °F	250
Design flow rate, gpm	35
Retention of 25 micron particles	98 percent
Material of construction	Austenitic stainless steel

TABLE 9.3-6 (Cont)

Relief Valves	No.	Fluid Discharged	Fluid Inlet Temperature °F	Set Pressure psig	Backpressure, psig Constant	Backpressure, psig Building	Capacity gpm
Letdown line (HP)	1	Water-Steam Mixture	385 (max)	600	3	50	98,000 lb/hr
Seal water return line	1	Water	150	150	3	50	180
Charging pump's discharge	1	Water	130	2735	15	75	100
Letdown line (LP)	1	Water	127	200	15	12	200
Volume control tank	1	Hydrogen, nitrogen, or water	130	75	3	12	350
Boric acid batch tank heater	1	Steam	250	20	0	0	320 lb/hr
Holdup tanks	3	Nitrogen, water	130	12	3	3	235

TABLE 9.3-7

FAILURE ANALYSIS OF THE CHEMICAL AND VOLUME CONTROL SYSTEM

Component	Failure	Comments and Consequences
1. Letdown Line	Rupture in the line inside the reactor containment	The two remote air-operated valves located near the main coolant loop are closed on low pressurizer level to prevent supplementary loss of coolant through the letdown line rupture. The containment isolation valves in the letdown line are automatically closed by the containment isolation signal. The closure of these valves prevents any leakage of the reactor containment atmosphere outside the reactor containment.
2. Normal and Alternate Charging Line	See above.	The check valves located near the main coolant loops prevent supplementary loss of coolant through the line and isolate the Reactor Coolant System from the rupture. The check valve located at the boundary of the reactor containment prevents any leakage of the reactor containment atmosphere outside the reactor containment. The two motor-operated valves outside the containment are automatically closed by the containment isolation signal.
3. Seal Water Return Line	See above.	The motor-operated isolation valves located inside and outside the containment are automatically closed by the containment isolation signal. The closure of these valves prevents any leakage of the reactor containment atmosphere outside the reactor containment.

Figure F9.3-1A Sheets 1, 2, 3 & 4 of 4 intentionally deleted.

Refer to plant drawing 205217 in DCRMS

Figure F9.3-1B Sheets 1 & 2 of 2 intentionally deleted.

Refer to plant drawing 205317 in DCRMS

Figure F9.3-2A Sheets 1, 2 & 3 of 3 intentionally deleted.

Refer to plant drawing 205247 in DCRMS

Figure F9.3-2B Sheets 1, 2 & 3 of 3 intentionally deleted.

Refer to plant drawing 205347 in DCRMS

Figure F9.3-2C intentionally deleted.

Refer to plant drawing 604495 in DCRMS

Figure F9.3-3A Sheets 1, 2, 3 & 4 of 4 intentionally deleted.

Refer to plant drawing 205244 in DCRMS

Figure F9.3-3B Sheets 1, 2, 3 & 4 of 4 intentionally deleted.

Refer to plant drawing 205344 in DCRMS

Figure F9.3-4A Sheets 1, 2 & 3 of 3 intentionally deleted.

Refer to plant drawing 205227 in DCRMS

Figure F9.3-4B Sheets 1, 2 & 3 of 3 intentionally deleted.

Refer to plant drawing 205327 in DCRMS

Figure F9.3-5A Sheets 1 & 2 of 2 intentionally deleted.

Refer to plant drawing 205226 in DCRMS

Figure F9.3-5B Sheets 1 & 2 of 2 intentionally deleted.

Refer to plant drawing 205326 in DCRMS

Figure F9.3-6A Sheets 1, 2 & 3 of 3 intentionally deleted.

Refer to plant drawing 205228 in DCRMS

Figure F9.3-6B Sheets 1, 2 & 3 of 3 intentionally deleted.

Refer to plant drawing 205328 in DCRMS

Figure F9.3-7A Sheets 1, 2 & 3 of 3 intentionally deleted.

Refer to plant drawing 205229 in DCRMS

Figure F9.3-7B Sheets 1, 2 & 3 of 3 intentionally deleted.

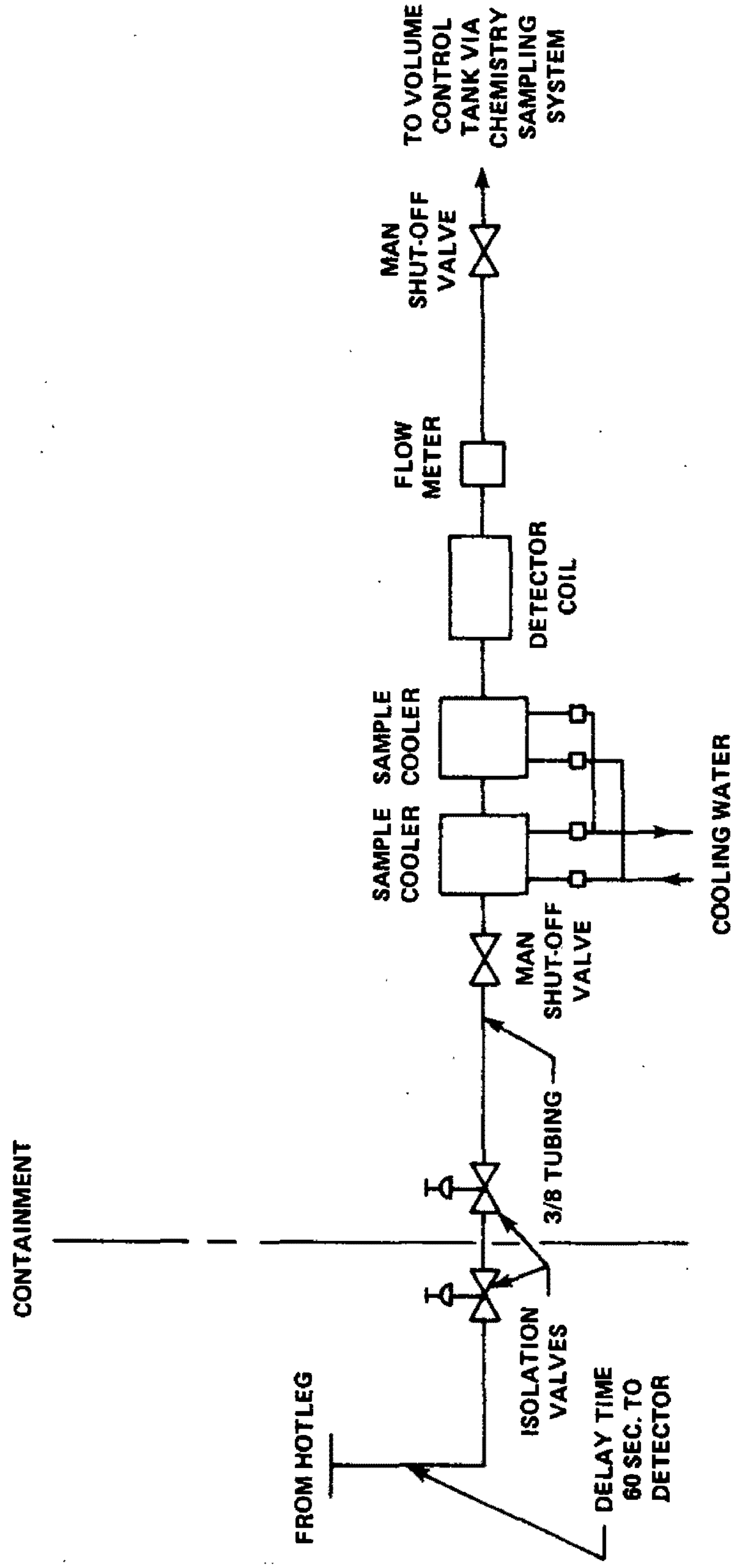
Refer to plant drawing 205329 in DCRMS

Figure F9.3-8A intentionally deleted.

Refer to plant drawing 205230 in DCRMS

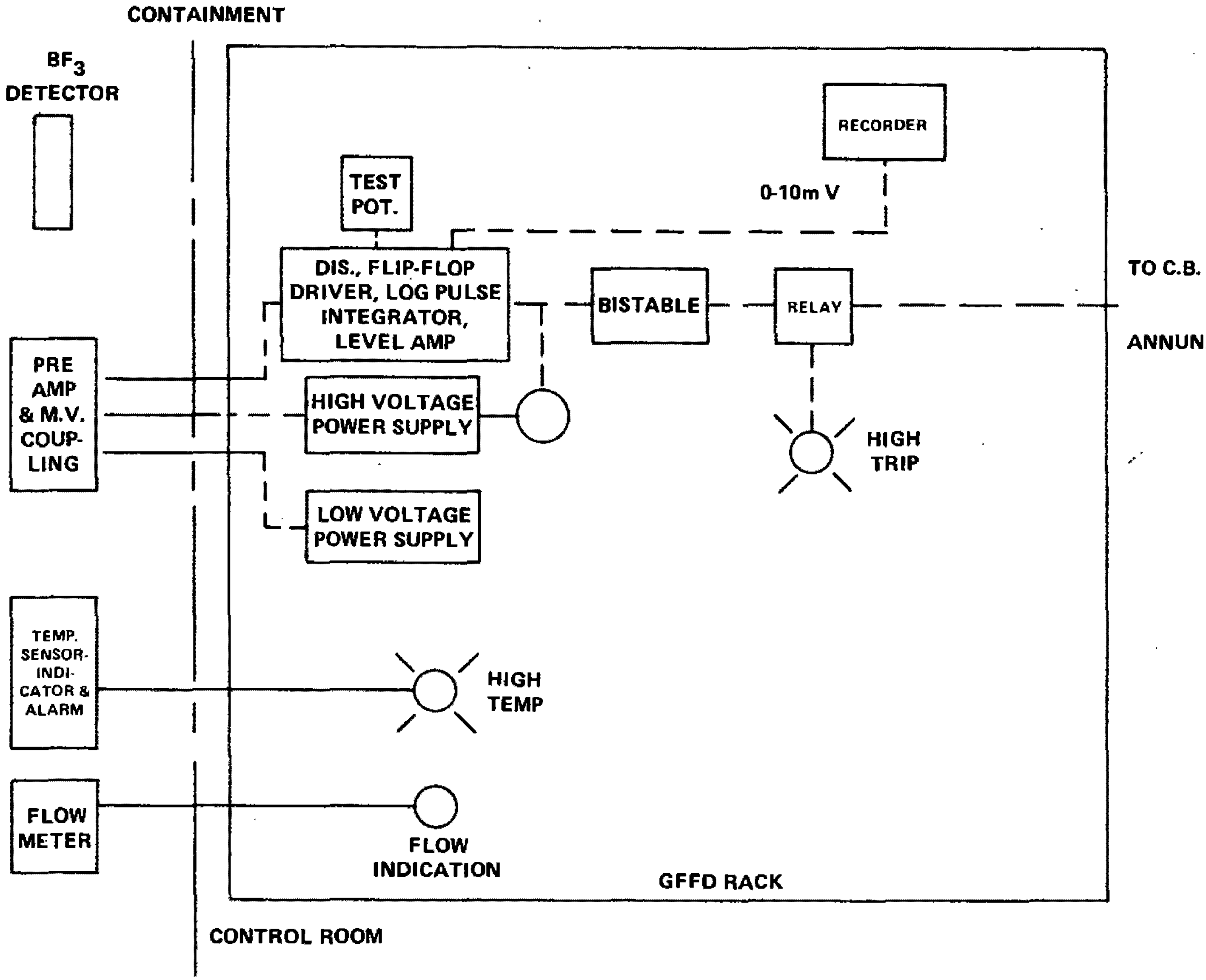
Figure F9.3-8B intentionally deleted.

Refer to plant drawing 205330 in DCRMS



REVISION 6
FEBRUARY 15, 1987

PUBLIC SERVICE ELECTRIC AND GAS COMPANY SALEM NUCLEAR GENERATING STATION	Gross Failed Fuel Detector Flow Diagram	
	Updated FSAR	Figure 9.3-9



REVISION 6
FEBRUARY 15, 1987

PUBLIC SERVICE ELECTRIC AND GAS COMPANY SALEM NUCLEAR GENERATING STATION	Gross Failed Fuel Detector Electronics Diagram
	Updated FSAR — Figure 9.3-10

9.4 HEATING, VENTILATION, AND AIR CONDITIONING SYSTEMS

9.4.1 Control Area Air Conditioning System

The Control Area Air Conditioning System (CAACS) and the Control Room Emergency Air Conditioning System (CREACS) are designed to maintain room temperatures within limits required for operation, maintenance and testing of plant controls, and permits continuous occupancy under normal and design accident conditions.

9.4.1.1 Design Bases

The CAACS maintains the control room area ambient temperatures of 76°F dry bulb and a maximum of 50 percent relative humidity based on outside air temperatures ranging from 0°F winter dry bulb to 95°F summer dry bulb and 78°F summer wet bulb during normal and emergency conditions.

The CREACS maintains room ambient temperatures inside the Control Room Envelope (CRE) within 55° to 85°F during emergency conditions, except for the Data Logging Rooms which are maintained within 55°F to 90°F, based on outside air temperatures ranging from 0°F winter dry bulb to 95°F summer dry bulb and 78°F summer wet bulb during emergency conditions.

In addition, the CAACS/CREACS design bases provides for the following:

(1) Protection of the CRE and control room areas (relay and control equipment rooms) from infiltration of fire, smoke, or airborne radioactivity by use of minimum leakage penetrations, weather stripped doors, absence of outside windows, and by maintenance of a positive pressure during normal operation.

(2) Protection of the CRE from a radiological design bases accident by filtering airborne activity and maintaining the CRE at a combination of 1/8 inwc and 1/16 inwc positive pressure differential above the outside environment and adjacent rooms. The dp is 1/8 inwc for all adjacent areas except the relay rooms, which is 1/16 inwc.

(3) Protection from airborne toxic gas or hazardous chemical releases outside the control room area.

(4) Protection from the smoke generated inside or outside the control room area.

(5) Maintains ambient temperatures within 55° to 85°F in the control room and adjoining equipment room for personnel comfort and instrument accuracy; from 65° to 85°F in the Relay Room and Unit 2 125 VDC Battery Rooms; and from 65° to 95°F in the Unit 1 125 VDC Battery Rooms during normal plant operating conditions.

(6) Remains operable during a design basis seismic event.

9.4.1.2 System Description

The control room area for each unit consists of the unit control room, a data logging room, a control equipment room, and a relay room. The operator ready room, conference room, control room supervisor's office areas, and both units control rooms are located in a common protected area or Control Room Envelope (CRE). The CRE area is serviced by both units CAACS during normal operating conditions and both units CREACS during emergency conditions.

Normal access to the control area is attained through the Auxiliary and Service Buildings. The control area is enclosed in a Class I (seismic) structure. The air handling equipment for each control area is housed in the equipment room adjacent to its respective control room inside the Auxiliary Building. The seismic design and analysis methodologies used to qualify all ductwork and the contained equipment are described in Section 3.8.4.4.1. The CAACS is shown in Plant Drawings 205248 and 205348. The area adjacent to the control room area (which is comprised of the work control center, field SRO office and a toilet room) is separated from the control room area envelope, does not contain any safety related equipment and is therefore provided with an independent non-safety related system consisting of a roof-top heating and cooling unit, a toilet exhaust fan, and non-seismically supported ductwork, which are also shown on Plant Drawing 205248.

The CAACS consist of a filter enclosure equipped with medium and low efficiency filters, three vane-axial fans (one standby), a multi-zone coil unit with three cooling coils and one heating coil, air distribution ducts and electrically or pneumatically operated dampers (with manual backup operators). Each CAACS primarily serves its units equipment room and relay room areas. The operator ready room, control room supervisor areas, and both units' data logging and control rooms are serviced by both units CAACS during normal operation and smoke generated inside the CRE.

The CREACS, a portion of the CAACS, operates to ensure continuous occupancy of operating personnel in the CRE under emergency conditions. The CREACS supplies cooled high-efficiency particulate air (HEPA) and charcoal filtered air to the CRE when actuated by the Solid State Protection System (SSPS) or control room intake high radiation signal. The CREACS consists of a filter enclosure equipped with HEPA and charcoal filters, a cooling coil, two vane-axial fans (one standby), supply and return ducts to the control room envelope, outside air intakes (crosstied between unit 1 and 2 CREACS filter units), distribution plenum above the control room conference room, and electrically or pneumatically and manually operated dampers.

Both units CREACS operates simultaneously in pressurized mode during a radiological design bases accident and in full recirculation mode during a toxic gas, hazardous chemical release, or smoke generated inside the control room area. Provisions in the design provide for a single CREACS train to be operated and provide long term occupancy in the CRE during a radiological condition.

The CAACS and CREACS cooling coils are supplied with chilled water from the Chilled Water System located in each unit's mechanical equipment area located at elevation 100 foot of the Auxiliary Building. Each unit's Chilled Water System consists of three 50% capacity package chiller units, two 100% capacity recirculating pumps, condensers cooled by the service water system (SWS), and interconnecting refrigeration, service water and chilled water piping. The Chilled Water System has a side stream demineralizer to maintain water chemistry and a recirculation line from the chilled water pump (1CHE6, 2CHE7) to the chilled water expansion tank (1CHE1, 2CHE8) drain line to prevent stagnant water conditions in the tank. The demineralizer and recirculation line are added as a part of the plant life extension commitments. The Chilled Water System has ample capacity to cool the areas serviced by CAACS and CREACS during normal and emergency operating conditions. During single CREACS train operation, the associated cooling coil is provided with sufficient chilled water with two chillers in service to maintain temperatures inside the CRE below 85°F at outside summer design conditions, except for the Data Logging Rooms, which are maintained below 90°F. The air conditioning equipment is designed to Class I (seismic) criteria and can be energized from the standby ac power supply.

Depending on outside climatic conditions, one or two CAACS fans per unit are normally in operation, the third serving as standby. The CREACS is isolated and in standby during normal operation. The CAACS normally operates with a fixed amount of outside air to maintain a slight positive pressure in the CRE.

The control area ventilation system has four modes of operation. They are as follows:

Normal (Mode 1)

This is the operating mode for CAACS during normal plant operations. In this mode, a mixture of outside air and recirculated air is supplied to the control room areas (relay room, equipment room, and the CRE) to maintain design temperature conditions within limits. Typically, one or two supply fans are operating with the third acting as a backup. The outside makeup (CAA40 & 43 open) and recirculated air is mixed and filtered through roughing filters, cooled (or heated), and supplied to the control room areas. The CRE and control room areas (relay and control equipment rooms) are maintained at a positive pressure. The CREACS is isolated and in standby.

Fire Inside Control Area (Mode 2)

In the event of a fire or smoke generated in the control room, each units CAACS is manually initiated by the operators for once through, 100% outside air operation or purge. In this mode, all of the normal intake (CAA40, 41, 43 & 45) and exhaust dampers (CAA18 & 19) open and return damper (CAA5) closed to allow 100% outside air to be pumped through the control room areas and expelled to the outside, thereby making the control room habitable. A maximum of two CAACS supply fans can be operating in this mode. Roughing filters are used for filtering the outside air. The CREACS is isolated and in standby.

Fire Outside Control Area (Mode 3)

In the event of airborne toxic gas, hazardous chemical releases, or smoke from outside the control room, provisions are made for 100% recirculated air. In this mode, all of the normal intakes (CAA40, 41, 43 & 45), emergency intakes (CAA48, 49, 50 & 51) and exhaust (CAA18 & 19) dampers are closed isolating the ventilation systems from the outside environment. The Unit 1 and 2 CAACS are isolated from the CRE (by closure of CAA14 and CAA20 dampers) and operates in the full recirculation supplying cool air to the relay and equipment rooms, while both unit's CREACS operate to recirculate air to the CRE. A maximum of two CAACS supply fans and one CREACS supply fan per unit can be operating in this mode. Chilled water control valve CH74 open and CH168 is permanently open to supply chilled water to the CAACS and CREACS coils, respectively. Recirculated air to the control room envelope passes through a cooling coil and high efficiency particulate air (HEPA) and charcoal filter banks. This mode is manually initiated by the operators from both control rooms.

Accident Pressurized - Two Filtration Train Alignment (Mode 4)

A mode of operation has been provided in the event of airborne radioactivity and long term occupancy of the control room. In this mode, all of the normal intake (CAA40, 41, 43 & 45), exhaust (CAA18 & 19), and CRE boundary (CAA14 and CAA20) dampers are closed isolating both units CAACS from the outside environment and the CRE. Chilled water control valve CH168 is permanently open. The CAACS operates in Mode 3 with CH74 valve open. An emergency intake from one unit will open and the opposite will remain closed based on which unit initiated the accident signal. Both CREACS filtration trains will start with one fan operating in each unit. If one of the fans fails to start, the standby fan will automatically start.

Each CREACS filter unit will draw in 1100 scfm of outside air mixing with 7000 scfm recirculated air from the CRE. The total of 2200 scfm makeup air ensures that the CRE is pressurized to greater than a combination of 1/8 inwc and 1/16 inwc differential above the outside environment and adjacent rooms. The dp is 1/8 inwc for all adjacent areas except the relay rooms, which is 1/16 inwc. The recirculated air and outside makeup air is filtered through HEPA and charcoal filters to remove airborne radionuclides and is cooled by a cooling coil. The CAACS operates in Mode 3 recirculating air to control room areas outside the CRE. The CAACS and CREACS automatically actuates upon an accident signal (SI or high radiation) and selects the preferred emergency intake.

In the event that the automatic selection of the preferred intake is unavailable, the operator can manually place the CREACS into Mode 4 service with the preferred emergency intake selected to any unit at power or shutdown.

Single Filtration Train Alignment

The control area ventilation system has provisions to allow for a single CREACS train to be out of service for maintenance. In this alignment, a single CREACS filter train is capable of providing ample cooling, filtering of recirculated and makeup air, and pressurization of the CRE to ensure continuous occupancy of personnel in the control room. In this standby alignment, one CREACS train on one unit is isolated and the other train is aligned (using manual dampers) for cooling the entire CRE with the CREACS train in standby. In this alignment, while in the standby condition, the CAACS fans on the side where CREACS is aligned continues to supply cooling to its respective Electrical Equipment Room/Relay Room (EER/RR) as well as the entire CRE. On the side where the CREACS is isolated, the CAACS supplies only it's respective EER/RR. If an accident were to occur, the system would automatically align as described in the Accident Pressurized Mode (Mode 4) except one CREACS train is now aligned to supply the entire CRE. The manual dampers (VHE1058, VHE1130, VHE1133 and VHE1141) when positioned ensure that a total of 2200 scfm of makeup air is provided and that supply air is distributed throughout the CRE. Return damper CAA17 on the CREACS unit aligned to the Single Filtration Train mode is administratively controlled to the open position. The air intake dampers must remain capable of automatically actuating and aligning the outside air intake to the non-accident unit's intake damper, upon receipt of a Safety Injection (SI) or a High Radiation signal, when both units are in modes 1-4.

SYSTEM CONTROLS

Both Units 1 and 2 control room ventilation systems are designed to initiate Mode 4 operation automatically upon any one of the following signals:

(1) Safety Injection signal from Unit 1

(2) Safety Injection signal from Unit 2

(3) High outside air activity from Unit 1 control room intake monitor

(4) High outside air activity from Unit 2 control room intake monitor

The automatic selection of emergency intake dampers that open during Mode 4 operation is based on the following:

(1) Safety Injection or control room intake high radiation signal from Unit 1 will open emergency intake dampers on Unit 2 (Unit 1 remain closed).

(2) Safety Injection or control room intake high radiation signal from Unit 2 will open emergency intake dampers on Unit 1 (Unit 2 remain closed).

The following monitoring devices are provided for the control room ventilation system:

(1) Smoke detectors are provided to detect trace amounts of combustion products

(2) Two safety related outside air activity monitors per intake monitor air entering the control room supply duct. These monitors are beta scintillation type detectors with a range of 10^1 - 10^7 cpm. These monitors have an instrument failure alarm, indication in the control room, and alarm to the control room. The same radiation monitor that generates the alarm is also used for automatic initiation of Mode 4 to isolate and pressurize the CRE.

(3) One non-safety related area monitor per unit is mounted in the control room. These monitors are GM type detectors with a range of 10^{-1} - 10^4 mR/hr (Unit 1) and 10^{-1} - 10^6 mR/hr (Unit 2). These monitors have an instrument failure alarm, local readout, and alarm to the control room. This monitor serves to provide indication only in the control room.

The dampers actuated in the CAACS and CREACS are pneumatically controlled and have position indication in the control room for vital automatic dampers. The dampers required to operate during Mode 4 conditions are designed to fail to their designated position upon loss of control air or power. These dampers automatically actuate to the designated positions upon signals from the Solid State Protection System (SSPS) and the radiation monitoring system (RMS). All vital dampers can also be operated manually at the damper.

The control room ventilation system has provisions to allow the operators to manually initiate the CAACS and CREACS to any of the operating modes from the control room.

9.4.1.3 System Design Evaluation

9.4.1.3.1 CREACS Single Failure Design

The CREACS ventilation design has been evaluated for single failure vulnerabilities and impacts on control room habitability requirements during an accident.

The CAACS and CREACS designs provide for redundant pneumatically operated isolation dampers (with manual backup operators) and controls for isolating the outside environment from the control room areas. These dampers are designed to fail to their designated positions for Mode 4 accident operation as described in 9.4.1.2. In addition, each unit's emergency intakes are provided with dual parallel flow paths, each with redundant pneumatically operated dampers in series with a manual isolation damper for maintenance. These pneumatic dampers are provided with redundant actuation signals and are supplied from separate control air headers to ensure that emergency makeup air is supplied to pressurize the CRE during an accident.

Dampers not providing isolation from the outside environment are single pneumatically operated dampers. Dampers relied upon during emergency conditions are provided with redundant actuation signals and are spring loaded to their fail safe positions upon a loss of control air or power (CAA14, CAA17, and CAA20). These dampers are also provided with manual backup operators and position indicators in the control room.

Operation of required dampers, valves and fans during an emergency condition is ensured by providing redundant controls. Each unit consists of two trains of controls circuitry supplied from separate vital control power and control air sources. The control scheme is designed such that on a loss of control power or air, the CAACS and CREACS will fail safe to the designated position for Mode 4 operation. Each unit's controls are initiated from redundant trains of SSPS and control room intake radiation monitors.

Each CREACS filtration train is provided with two 100% capacity supply fans supplied by the standby A/C power supply. In the event that one fan fails to start, a safety related flow switch located downstream of the fan discharge duct will start the standby supply fan. Control switches located in the control room are provided to allow the operators to select the lead and standby emergency fans. In the event maintenance is required on a filter unit, the operators manually place the system in the standby alignment condition for a single CREACS filtration train operation. In the Maintenance mode, a single CREACS filtration train is capable of providing adequate cooling, removal of airborne activity, and pressurization of the CRE during the course of an accident for long term occupancy. While in the Maintenance mode, CREACS return damper CAA17 is administratively blocked open.

9.4.1.3.2 Shared Systems, Structures, or Components

Since the SGS Unit 1 and 2 control rooms are common, the ventilation design and operating modes for CAACS and CREACS are evaluated for impacts for shared system design (GDC 5). The following areas of the ventilation design were evaluated:

(1) Supply Distribution Plenum to CRE
(2) Outside Emergency Intake Plenum
(3) Unit 1 and 2 CREACS supplying CRE
(4) Single Filtration Train operation (Maintenance mode)
(5) Ventilation Control Circuitry
(6) Control Room Intake Radiation Monitors

Supply Distribution Plenum to CRE

This supply distribution plenum and associated manual dampers are designed to Class I (seismic) criteria. This common supply plenum serves to distribute air to the rooms within the CRE.

Outside Emergency Intake Plenums

The emergency air intake plenums for each unit is cross-connected by a common ductwork to allow each unit's CREACS or a single unit's CREACS the ability to draw outside makeup air from the selected or preferred intake. The emergency air intake and distribution plenums are designed to Class I (seismic) criteria. The emergency air intake plenums for each unit are designed with dual parallel flow paths, each flow path consisting of a redundant series of dampers actuated by redundant controls. The sources of power and control air for each unit's intake dampers are not shared between units.

CREACS Supplying CRE

Normally, during an emergency condition, both units CREACS will operate simultaneously, each CREACS supplying cool filtered air to the CRE to maintain habitability requirements.

Single Filtration Train Operation

In the event that one CREACS filtration train is out of service for maintenance, the operators manually place the system in the standby alignment condition to a single filtration train operation (Maintenance mode). A single CREACS train is capable of providing adequate air to cool the CRE and ensures control room habitability requirements are met during an accident.

Ventilation Control Circuitry

The controls for actuating the CAACS and CREACS to the accident mode of operation (Mode 4) and for single filtration train alignment are shared between Unit 1 and 2 control area ventilation control circuitry. This is based upon each unit's train of control circuitry being electrically interlocked with the opposite unit's controls. This interlock enables the opposite unit's CAACS and CREACS controls to automatically initiate to Mode 4 operation. This interlock is electrically isolated and separated from the other unit's control power. The pneumatic controls are completely separated and are not cross-connected between units. Each unit's actuation controls are redundant, and electrically and physically separated. The interlock between units is electrically isolated and is only interconnected to the same division or train on the opposite unit. The control air and electrical power sources are not shared between units, and therefore, the onsite power system capacities are not impaired.

Control Room Intake Radiation Monitors

The radiation monitors monitor both unit's intake and provide actuation functions to Unit 1 and 2 ventilation controls and are considered shared. These monitors are redundant and safety related. A monitor is located in each unit and is capable of monitoring normal makeup air on each unit's intake plenums. Therefore, each unit's intake plenum consist of redundant detectors from separate radiation monitors located in different units. The power sources to these monitors are not shared between units and the actuating functions to both unit's ventilation controls are separated and isolated.

Conclusion

The shared ductwork is designed to seismic I criteria and will maintain its safety function during an accident.

The capacity of the onsite power sources are not impaired by the sharing of the control area ventilation system. In the cases evaluated herein, the power sources for the ventilation equipment (fans) and controls (relays, solenoids, damper actuators) are not shared between Units 1 and 2. In fact, the sharing is based on the function of the SSC being shared between the units, in which case, provisions in the design ensures for adequate separation and isolation between units SSC and redundancy of the shared SSC, such that the safety function is not impaired per GDC-5 criteria.

9.4.1.3.3 Detection of Adverse or Dangerous Environment Conditions

The control room is provided with smoke detectors and radiation detectors located in the control room and in the normal intake plenums. The smoke detectors monitor for trace amounts of combustion and alarm to the control room. Redundant radiation monitors are provided that monitor the normal incoming makeup air to the control room areas for airborne radioactivity. A radiation monitor is also provided in each control room that serves to provide radiation levels in the area. Human detection by the control room operators is also relied upon for the detection of other hazardous conditions (e.g., smoke, ammonia, etc.).

9.4.1.3.4 Capability to Exclude Contaminants

The CAACS and CREACS is designed to cope with preventing the entry of contaminants by operating in the following modes:

(1) CAACS in Normal operation (Mode 1) with outside makeup air maintains a positive pressure inside the control room areas and the CRE during normal operation and use of minimum leakage dampers, minimum leakage penetrations, weather stripped doors, and absence of outside windows to limit infiltration of air, smoke or airborne radioactivity from other rooms in the control area and Auxiliary Building. The CAACS does not use exhaust fans and relies on the supply fan pressure to deliver air flow into the room areas. With this design, minimizing leakage in the rooms and makeup air, the control room areas can be maintained at a positive pressure limiting entry of contaminants.

(2) Full recirculation (Mode 3) of CAACS and CREACS with the outside environment isolated due to smoke, toxic gas, or hazardous chemical released outside the control room. This mode is initiated manually by the operator upon detection.

(3) CREACS pressurizing (Mode 4) the CRE and CAACS in full recirculation for radiological accident. This mode can be initiated automatically or manually.

9.4.1.3.5 Capability for Removal of Contamination

The CREACS filtration train consists of a High Efficiency Particulate Air (HEPA) and charcoal filters. The HEPA filters have a removal efficiency of 95% and the charcoal filters have a removal efficiency for radioiodine of 95%. The Unit 1 and 2 CREACS filtration units will automatically be placed in service during a radiological accident, filtering recirculated air from the CRE and makeup air from outside the control room. In addition, a single CREACS filtration train, when operated in the Maintenance mode, is capable of providing adequate removal of airborne contaminants during an accident to ensure the doses in the CRE are within the limits of GDC 19 criteria.

9.4.1.3.6 Removal of Contamination by Purging

Purging of the control room areas is provided by the operators manually initiating the system to the Mode 2 operation. In this mode, all of the normal outside air intake plenum dampers go open, providing 100% outside air to be drawn into the control room areas. Exhaust dampers go open to allow the contaminants to be expelled to the outside environment. The CREACS is isolated and in standby in this mode.

9.4.1.3.7 Capability of Ensuring Ambient Room Temperatures

The control area ventilation system has adequate capacity to ensure ambient temperatures in the rooms are maintained within limits during normal and emergency conditions. A system air balance was performed and adjustments made for the required design values. A chiller capacity test was performed on one of the chillers. A system balance on the CWS was performed. Inspection on the CREACS coils was performed. These tests reasonably demonstrate the capability of the system to remove the heat loads during normal and emergency conditions to maintain the control room areas and the CRE within temperature limits.

9.4.1.3.8 Capability for Single CREACS Filtration Train

In the event that one of the unit's CREACS filtration trains require maintenance, the operators manually place the system in the standby alignment condition to operate with a single CREACS filter train (Maintenance mode). Once the CREACS unit is in the Maintenance mode, an automatic initiation will initiate accident pressurized and will pressurize the CRE and maintain control room habitability during the course of an accident within GDC 19 limits.

9.4.2 Auxiliary Building Ventilation System

9.4.2.1 Design Bases

The Auxiliary Building Ventilation System is designed for long-term continuous operation during normal and emergency modes of plant operation to provide consistent levels of temperature, cleanliness, and negative pressure within the building. Standby equipment is included in the system to assure the maintenance of design conditions within the building and thus preclude the uncontrolled release of radioactivity to the environs.

The use of the Auxiliary Building exhaust filtration (HEPA and charcoal filters) to reduce release of radioactivity after the design basis accidents of Section 15 was eliminated. The accident dose analyses were re-done using an alternative source term in accordance with Regulatory Guide 1.183 (Ref. 1). The radioactivity released into the auxiliary building during these accidents was analyzed as being released by the Auxiliary Building Ventilation System through the plant vent without filtration.

Limitations on the operability and use of the Auxiliary Building Ventilation System HEPA and charcoal filters are to ensure that they are used to reduce releases of radioactivity in normal plant operation in conformance with Appendix I to 10 CFR Part 50 (Ref. 3). Limitations on the dose to areas beyond the SITE BOUNDARY conform to the doses associated with 10 CFR Part 20, Appendix B, Table II, Column 1 (Ref. 2) and environmental radiation releases from the uranium fuel cycle sources conform to 40 CFR Part 190 (Ref. 4). Gaseous releases during normal operation are done in accordance with the Salem Units 1 and 2 Offsite Dose Calculation Manual (ODCM) (Ref. 5) limits.

Auxiliary Building Ventilation equipment is utilized in performing containment purging. Containment purging is an intermittent operation where sampling and analysis requirements, prior to each purge, are performed in accordance with the ODCM (Reference 5). The equipment in the Auxiliary Building Ventilation System is available to purge the containment during normal reactor shutdown. Containment purging is limited by administrative controls as described in Section 9.4.4.3.1.

The total capacity of fans and filters is designed for the maximum required ventilation rate. That is, total capacity is based on summertime ventilation of the Auxiliary Building during normal power operation. This system operates to limit the average temperature of the Auxiliary Building to 110°F or less, and to maintain the Auxiliary Building boundary at a slight negative pressure.

The Auxiliary Building Ventilation System is designed to maintain a year-round range of average temperatures within the Auxiliary Building of 60-110°F. This is the temperature range chosen to size the ventilation equipment and not necessarily the space temperature requirements. Auxiliary Building equipment has been evaluated to operate at area temperatures to 110°F. Hot water coils in the supply air units are designed to provide 60°F air to the Auxiliary Building in winter and no less than 45°F air to the Containment Building. The design basis outdoor temperature is 0°F (winter) and 95°F (summer). Both values satisfy more than 99 percent of the conditions experienced at the site area annually.

A 24,000 cfm capacity charcoal filter is part of the Exhaust Air System to maintain ODCM limits and remains in standby during normal system operation. It can be lined up to remove gaseous iodine from the exhaust effluent during gaseous effluent releases. The charcoal filter (though not credited in accident analyses) is capable of treating the effluent from ECCS areas served, which have the highest potential for radioactive contamination.

Individual room coolers, in conjunction with the once-through ventilation air, are designed to limit the ambient room temperature to the vital pumping equipment rooms. Maximum allowable ambient temperature in vital pump rooms will not be exceeded assuming a single failure of any individual room cooler or electrical bus. The maximum allowable ambient temperatures are appropriately considered in the EQ program or other evaluations of equipment temperature tolerance.

These temperatures help to assure long-term and reliable operation of the pumps, motors,. controls and instrumentation and accessibility to this equipment for maintenance as required.

The exhaust fan-filter units in the Auxiliary Building Ventilation System and their controls are designed to seismic Class I criteria. They can be powered from the standby ac power supply during a loss of

offsite power. The distribution ductwork for the system is designed to seismic Class II criteria. Room coolers are seismic Class I and powered from the Standby AC Power System. The seismic design and analysis methodologies used to qualify all ductwork and the contained equipment are described in Section 3.8.4.4.1.

The design arrangement of the HEPA and charcoal filter exhaust units provides various filtering modes for ventilating the Auxiliary Building continuously and purging the containment intermittently. In order to purge the containment, standby equipment must be available.

The modes of operation are as follows:

NORMAL VENTILATION (Normal operations)

Normal ventilation is any two of the three exhaust fans and either of the two supply fans. During cooler seasons, and with the absence of the system heating coils, it may be required to limit the amount of colder outside air entering the building. In this case, it is acceptable to secure both supply fans from operation and reduce the number of operating exhaust fans to one. There is sufficient capacity with the single exhaust fan to maintain the negative pressure within the auxiliary building boundary.

EMERGENCY VENTILATION (Emergency plant operations)

Emergency ventilation (emergency plant operations) is any two of the three exhaust fans and either of the two supply fans. During a Safety Injection (SI) all three exhaust fans and one of the supply fans will start. This is acceptable and will maintain the boundary pressure while supplying the required cooling to the building. Should access/egress become difficult with the three exhaust fans running, one of the exhaust fans should be secured. The accident analysis does not credit HEPA or Carbon filtration.

REACTOR SHUTDOWN WITH CONTAINMENT PURGE (Modes 5 & 6)

HEPA UNIT 13 (23) CONTAINMENT PURGE EXHAUST in service with HEPA UNIT 11 (21) ECCS and HEPA UNIT 12 (22) NORMAL

OR

HEPA UNIT 12 (22) CONTAINMENT PURGE EXHAUST in service with HEPA UNIT 11 (21) ECCS and HEPA UNIT 13 (23) NORMAL

AND

BOTH SUPPLY FANS

Some of the Additional Alignments Available (Limited Use)

Reactor Shutdown with Containment Purge and Carbon Filtration (Modes 5 & 6)

1. *HEPA UNIT 12 (22) + CARBON UNIT 14 (24) CONTAINMENT PURGE EXHAUST in service with HEPA UNIT 11 (21) ECCS and HEPA UNIT 13 (23) NORMAL

2. *HEPA UNIT 12 (22) + CARBON UNIT 14 (24) NORMAL in service with HEPA UNIT 11 (21) ECCS and HEPA UNIT 13 (23) CONTAINMENT PURGE EXHAUST

During Normal Power Operations with 2 filter units and Carbon Filtration

3. *HEPA UNIT 11 (21) + CARBON UNIT 14 (24) ECCS in service with HEPA UNIT 12 (22) NORMAL
4. *HEPA UNIT 12 (22) + CARBON UNIT 14 (24) NORMAL in service with HEPA UNIT 11 (21) ECCS

*These alignments utilize the carbon filter bank as a solution to minor airborne contamination problems for ALARA concerns only and are being described here only to present this possible availability. These alignments may introduce airflows that exceed the carbon filter bank flow capacity. Note that in these conditions, the carbon filter bank may not be available for ECCS flowpath filtration.

THIS PAGE INTENTIONALLY LEFT BLANK

9.4.2.2 System Description

9.4.2.2.1 General Description

The Auxiliary Building Ventilation System is a once-through heating and ventilating system for each unit, with no connection or sharing between units, except for the drumming and boiling area and the auxiliary building elevator shaft. The Auxiliary Building Ventilation System is shown on Plant Drawings 205237 and 205337. The Control Room and its associated areas are provided with a separate Heating, Ventilating and Air Conditioning System as described in Section 9.4.1. Ventilation of the diesel generator area and Fuel Handling Building is described in Sections 9.4.3 and 9.4.5. The post-accident Sampling Room is located in the Unit 2 Auxiliary Building and is served by the Unit 2 Auxiliary Building Ventilation System. A local booster fan is provided for exhausting air from the post-accident Sampling Room.

The Auxiliary Building is a multi-level compartmented structure containing the auxiliary nuclear equipment and systems required for the normal, shutdown and emergency modes of unit operation. The Auxiliary Building Ventilation System operates continuously during these modes of operation to perform the following functions:

1.Provide satisfactory ambient temperatures within the building.

2.Direct airflow within the building always from the clean areas to the heat producing, contaminated, or potentially contaminated areas.

3.Maintaining the building at a slight negative pressure to control the release of particulate and gaseous contamination from the building in accordance with 10CFR20 limits.

4. Purge the Containment Building at selected intervals (shutdown modes only) limited by administrative controls as described in Section 9.4.4.3.1.

The Auxiliary Building Ventilation System is comprised of supply and exhaust air systems and a network of individual room coolers. The Supply Air System consists of two 100-percent capacity fan filter units, hot water heating coils, controls, instrumentation and distribution ductwork. The Exhaust Air System consists of three 50-percent capacity fans, three HEPA filter units, one standby charcoal filter unit, controls, instrumentation and distribution ductwork. The room coolers are packaged fan cooler units supplied with service water and mounted locally near vital pumping equipment (residual heat removal, safety injection, compo nent cooling, auxiliary feedwater, charging, and containment spray pumps).

Supply air taken from outdoors is delivered primarily to the clean aisles and walkways, although some air is supplied directly to the Residual Heat Removal (RHR) pump pits at the base of the building. Exhaust air is extracted from each room and compartment and delivered to the unit vent alongside the Containment Building. The unit vent effluent is continuously monitored for radioactivity. The room coolers recirculate air around the equipment in the room when required. One branch of the exhaust ductwork is used exclusively for those rooms and compartments that would have the highest potential for radioactivity during a LOCA in the containment (Residual Heat Removal, Safety Injection and Charging Pump Rooms; main pipe chase; Spent Resin Rooms; and the containment piping penetration area).

The Auxiliary Building Ventilation System continuously maintains the building at a slight negative pressure with respect to outdoors.

The starting, stopping, and mode of operation of the system are manually controlled from the Control Room. The exception to this is the pump room coolers, which will auto-start on rising temperatures in their respective pump rooms while in auto position. After being placed in operation, the system automatically maintains building temperature and pressure within satisfactory limits. System performance and building conditions are monitored from the Control Room.

9.4.2.2.2 System Operation

Automatic controls are provided to maintain the building within the design values of pressure and temperature. A temperature switch provides two position modulation of fan capacity from 2/3 airflow capacity to full capacity as the average building temperature varies from 60°F in winter to 110°F in summer. Simultaneously, a differential pressure controller modulates the exhaust fan capacity between 2/3 and full to maintain the building at a slight negative pressure with respect to outside. This temperature and pressure control for the Auxiliary Building continues to operate even when containment purging is required.

In the event of a LOCA, the Auxiliary Building ventilation equipment continues to operate in its normal mode. That is:

1. One of the two supply air units provides two-position modulation of filtered air to the building in response to building exhaust air temperatures. One (1) supply fan is enabled and one (1) supply fan can be blocked for auto start on receipt of a SEC (LOCA) signal. The blocked supply fan's outside air inlet damper is maintained open.

2. Two of the three HEPA filter units and exhaust fans operate while fan inlet guide vanes continuously modulate flow in response to building negative pressure.

The following operations occur automatically:

1. Room coolers will start automatically and operate continuously at full capacity in response to the above normal ambient temperatures that develop as the RHR, containment spray, charging, safety injection, component cooling, and auxiliary feedwater pumps are started. However, in the event that vital power is being provided by diesel generators, the room coolers for the RHR charging, and containment spray pumps may be delayed for up to 20 minutes.

2. Containment purging is terminated.

Thereafter, operator action is required if trouble or failure alarms sound in the Control Room:

1. The standby supply air unit can be energized if the operating unit signals low air flow, high or low supply air temperature, or a break in the hot water heating coil.

2. The standby HEPA filter exhaust unit can be placed in service if either of the other two operating units experience high differential pressure.

3. The standby exhaust fan can be energized if either of the two operating fans experience an operational problem.

4. The loss of power fail-safe damper positions ensure one HEPA filter exhaust unit and charcoal filter unit are available for the ECCS equipment areas. The remainder of the Auxiliary Building areas are exhausted through the HEPA filter unit to the Unit vent without passing through the charcoal filter unit.

The damper at the outlet of the charcoal filter consists of two operating sections, each with an operator. Damper blades are designed to go to the full open position in the event that control air or electric control power is lost. Manual control air bypass valves are available near the charcoal filter unit damper operator in the event the single solenoid valve for the two damper sections experiences a mechanical failure. In addition, each damper section can be manually positioned locally to the required position.

9.4.2.3 Design Evaluation

The Auxiliary Building Ventilation System can maintain design conditions in the Auxiliary Building with one of the two 100-percent capacity fan-filter supply air units, two of the three 50-percent capacity exhaust fans, and two of the three HEPA filter exhaust air units operating.

The charcoal filter exhaust air unit is normally in standby. Exhaust fans take suction from a common plenum at the outlet side of the HEPA and charcoal filter units, which permits changes in the exhaust filter operating mode without affecting fan operation.

The system is normally operated from the Control Room. Supply air to the Auxiliary Building and to the containment is filtered by high efficiency filters. This high quality filtration significantly reduces the inventory of particulates that could become contaminated and lessens the loading on the more vital exhaust air filters.

All exhaust air from the Auxiliary Building and Containment (during purge operation) is processed through HEPA filters which remove at least 99 percent of all particles 0.3 micron and larger in size. In the event of a LOCA, no change is required in the operating mode in effect for the Auxiliary Building. If there is indication of excessive radiation levels in the Auxiliary Building, the charcoal filter can be aligned to the ECCS flowpath through either 11 (21) HEPA or 12 (22) HEPA units as required. The HEPA and charcoal filters are credited to control releases to ODCM limits and are not credited in the Chapter 15 accident dose analysis.

During any LOCA, the room coolers for pumps listed in Section 9.4.2.1 are automatically energized (the fan motor starts and a service water supply valve opens in response to increasing temperatures) to operate at full capacity continuously. In the event that the temperature in a pump room exceeds its specified upper limit, an alarm is sounded in the Control Room.

In general, ventilation air is supplied to the areas having the least potential for contamination and exhausted from the areas of potentially higher contamination. The Auxiliary Building is designed to be at a slight negative pressure continuously with respect to the outdoors. These design considerations satisfy the basic criterion for preventing the uncontrolled release of radioactivity.

Standby fan and filter capacity is included in the Auxiliary Building Ventilation System to assure that the design pressure, temperatures and air flow patterns for the building are controlled continuously during maintenance or testing. The system components subject to single failure have been reviewed for impact on system capabilities to perform its design basis function. Where identified deficiencies exist, engineering evaluations have been performed that support the required system performance level.

Filtration of the supply air from outdoors is designed to minimize the inventory of airborne particulates within the

Auxiliary Building and the containment. This reduces the potential hazard of irradiated particles being transported throughout the building and reduces the loading on the exhaust filters. The HEPA type exhaust filters, in turn, continuously minimize the release of particulate radioactivity to the environment while the standby charcoal filter is available to adsorb gaseous contamination. The design capability of a three-part high level filtration train ensures that all exhausted emissions from the Auxiliary Building and the containment are within the requirements of 10CFR20.

Availability of the Auxiliary Building supply and exhaust ventilation equipment is ensured by connection to the standby ac power supply.

The room coolers located near vital pumping equipment are single capacity units. The total capacity of the room cooler(s) in a given area, in conjunction with the exhaust air flow rate, is designed to limit the area temperature to the design values even if all pumping equipment in the area is operated continuously. In the event that the Safety Injection Pump Room cooler fails concurrent with operation of both SI pumps, temperature in the SI Pump Room may exceed 120°F. Equipment in this area will operate at temperatures to 146°F. Similarly, in the event that the 12 (22) Component Cooling Water (CCW) Room Cooler fails concurrent with operation of both CCW pumps in the room, temperatures in the 12 (22) CCW Heat Exchanger and Pump Room may exceed 120°F. Equipment in this area will operate at temperatures to 132°F.

9.4.2.4 Test and Inspections

All components of the Auxiliary Building Ventilation System are subjected to a test and inspection program. This program is similar to that described for the Containment Ventilation System (Section 9.4.4), except the resistance to LOCA pressure and temperature transients is not applicable to the Auxiliary Building equipment.

The Auxiliary Building exhaust air filtration system testing is contained in the Salem Technical Requirements Manual.

9.4.3 Fuel Handling Area Ventilation

9.4.3.1 Design Bases

The Ventilation System is designed to exhaust the spent fuel pool area at 60 air changes an hour within a 10-foot height above the pool during design conditions for spent fuel storage. Out of a system operating capacity of 20,000 cfm, 15,000 cfm is exhausted from the spent fuel pool area (10,000 of which is extracted right at the pool surface) and the remaining 5,000 cfm of system capacity ventilates other parts of the building.

Because of the potential for radioactive releases from the spent fuel, defective fuel cladding or a fuel handling mishap, the building is maintained at a slight negative pressure to assure inleakage of air rather than outleakage.

The total capacity of the Ventilation System, along with the area space heaters, is designed to maintain the building between 60°F and 105°F. The space heaters are not safety-related, do not receive Class 1E power, and would not be available during a loss of offsite power. An evaluation of the Fuel Handling Building has justified a minimum temperature of 40°F. Although there is no direct control of the humidity in the building and there can be instances of 100-percent relative humidity around the spent fuel pool when the outdoor air is damp, the relative humidity under design conditions is expected to be less than 70 percent.

The exhaust filter units, fans and controls are designed to Class I (seismic) criteria. The discharge ductwork from the fuel handling area to the plant vent is also designed to Class I (seismic) criteria. The supply air equipment is served by the Normal AC Power System only, whereas the exhaust air equipment can be energized from the Standby AC Power System in the event of a loss of offsite power. The seismic design and analysis methodologies used to qualify all ductwork and the contained equipment are described in Section 3.8.4.4.1.

9.4.3.2 System Description

9.4.3.2.1 General Description

The fuel handling area is a structure separate from other unit structures and is provided with its own ventilation system. This system is a once-through filtered air system that continuously ventilates the normal operating areas (fuel pools, decontamination pit, electrical equipment room and sump tunnel). The Fuel Handling Area Ventilation System is shown on Plant Drawings 205321 and 205322.

The Ventilation System consists of the following equipment:

1. One 100-percent capacity supply air unit with particulate filters at about 80-percent cleaning efficiency and a heating coil for winter-time tempering of the supply air

2. Two 50-percent capacity exhaust fans

3. One 100-percent capacity HEPA filter exhaust unit and one 100-percent capacity HEPA and charcoal filter exhaust unit available for standby

4. Controls and instrumentation

5. Distribution ductwork

6. Pressure relief damper

All exhaust effluent is diverted to the standby HEPA and charcoal exhaust unit in the event that radioactivity levels within the building become excessive. This exhaust effluent path through the HEPA and charcoal filters is not credited in the Fuel Handling Accident in the Fuel Handling Building. Control of the system and surveillance of building conditions are accomplished from the Control Room.

Air is distributed with overhead ducts for supply and exhaust, as well as embedded exhaust ducts around the spent fuel pool.

Supply air enters the building at the cask storage area, flows through the building to the spent fuel pool area, and is exhausted to the unit vent where the total plant effluent is continually monitored for radioactivity. Supply air may also enter through the pressure relief intake dampers at the truck bay when the supply fan is shutdown and only one exhaust fan is running. The Ventilation System maintains the building under a slight negative pressure and exhausts the heat and humidity emitted from the spent fuel pool.

9.4.3.2.2 System Operation

Normally the supply air unit, both exhaust fans and the HEPA exhaust filter unit operate continuously. The supply air unit operates at a constant volume. Exhaust air is varied through inlet guide vanes on each exhaust fan which are controlled by a differential pressure controller to maintain a negative pressure of approximately 0.125 inch water gage in the building. If the inside building temperature decreases to the minimum 60°F, the heating coil and controls at the supply air unit are energized and, together with the area space heaters, maintain the building at or greater than 60°F, even if the supply air inlet temperature should decrease to the minimum outside 0°F temperature, as could occur during winter conditions. Because the space heaters are not safety-related and do not receive Class 1E power, as during a loss of offsite power event, the minimum design temperature has been evaluated permitting temperature to decrease to 40°F.

In the event that a local radiation monitor detects excessive radioactivity in the building and alarms in the Control Room, the operator can divert the building effluent from the HEPA exhaust unit to the standby HEPA and charcoal exhaust unit. Also during the event, an automatic initiation of the exhaust fans will take place for Unit 2.

Additional alarms in the Control Room will signal adverse operating conditions: low or high supply air temperature, low air flow from the supply or exhaust fans, clogged HEPA filters, and insufficient negative pressure in the building.

9.4.3.3 Design Evaluation

The heating and ventilating of the fuel handling area is based on outdoor design conditions of 0°F in winter, 93°F dry bulb and 79°F wet bulb in summer. These values satisfy 99 percent of the

weather conditions experienced annually at the Salem site and offer a high degree of assurance that satisfactory temperature conditions will be maintained.

Directing the air flow from areas of least contamination to areas of higher contamination is accomplished in two ways. First, the building is maintained at a negative pressure such that outdoor air leaks into the building rather than building air leaking out. Secondly, air flow within the building is from the cask storage area to the spent fuel pool area.

Efficient filtration of the supply air minimizes the inventory of airborne particulates within the building. This reduces the rate of dirt buildup on the HEPA filter exhaust units and extends their useful life. Whereas the supply air filters can be replaced easily and safely as required, the HEPA exhaust filters are potentially radioactive and less maintenance is desirable.

The heat, humidity and potential radioactivity in the building is confined to the spent fuel pool area. Seventy-five percent of the building exhaust occurs in that area, and the 60 air changes per hour over the pool is a rapid exhaust rate. Two-thirds of this exhaust rate takes place just inches above the pool water through numerous, high velocity (2000 fpm) exhaust ports spaced around the pool periphery. These ports act to vacuum the surface of the pool and effect early capture of pool emissions.

The exhaust portion of the Fuel Handling Area Ventilation System includes one filtration unit containing only roughing and HEPA filters, and one filtration unit containing roughing and HEPA filters, and carbon absorbers. There are two (2) 50% capacity exhaust fans and one (1) 100% capacity supply fan.

The charcoal filter train is normally at standby and is inspected and tested periodically for availability, especially prior to refueling. This administrative control will assure the preparedness of the filter train and clogging of the train during the relatively short period of refueling or during a fuel handling accident is not anticipated. The Fuel Handling Accident in the Fuel Handling Building was analyzed without credit for filtration by the Fuel Handling Building Ventilation System.

(Historical Information)

Overheating of the carbon filters from radioiodine loading is not expected to occur. An analysis was performed using Safety Guide No. 25 assumptions assuming all the airborne radioiodine released during a design basis fuel handling accident was adsorbed on the charcoal filters. The resulting heat generation rate is negligible (less than 100 Btu/hr) compared to the heat generation rate required to elevate the carbon temperature (with airflow through the filters) to the point that de-adsorption or ignition occurs (greater than 100,000 Btu/hr).

The exhaust ductwork and exhaust fan-filter units leading from the fuel handling structure to the plant vent are seismic Class I design. Exposed ductwork along the walls within the structure is seismic Class II. The supply air unit, located below the fuel handling operating floor, is of non-seismic standard construction. The seismic design and analysis methodologies used to qualify all ductwork and the contained equipment are described is Section 3.8.4.4.1.

In the event of a seismic disturbance or a fuel handling accident that causes the failure of non-Class I equipment, the primary function of the Ventilation System will still be maintained. That is, the seismic Class I portion of the exhaust system will continue to operate, creating a negative pressure within the structure, and pass the exhaust through HEPA and charcoal filters. There would be no increase in building differential pressure and, therefore, radioactivity would be contained within the building.

A gravity pressure relief damper and a manual volume damper are provided in the exterior wall of the shipping bay.

9.4.3.4 Tests and Inspections

All components of the Fuel Handling Area Ventilation System are subjected to a program of tests and inspections. This program is similar to that described for the Containment Ventilation System (Section 9.4.4.4) except that resistance to LOCA pressure and temperature transients is not applicable to the fuel handling area.

9.4.4 Containment Ventilation System

9.4.4.1 Design Bases

Containment ventilation is subdivided into a number of independently controlled systems which perform specific functions for the containment during normal power generation, the design basis LOCA and a loss of offsite power. The systems are the following:

1. Containment Fan Cooler System

2. Containment Iodine Removal System

3. Rod Drive Ventilation System

4. Reactor Nozzle Support Ventilation System

5. Reactor Shield Ventilation System

6. Pressure - Vacuum Relief System

7. Containment Purge System

The containment ventilation flow diagram is shown on Plant Drawings 205238 and 205338.

Except for the Pressure-Vacuum Relief System and the Containment Purge System, both of which connect the containment atmosphere to the environment at controlled intervals, all systems are of the recirculation type, completely contained within the containment, which have sufficient redundancy to perform their required functions.

9.4.4.1.1 Containment Fan Cooler System

The Containment Fan Cooler System is an engineered safeguard that is designed to operate during normal power generation and "blackout" situations as well as during the design basis LOCA. The system is described in detail in Section 6.2.2.2.

This system removes heat from the containment atmosphere to limit the average temperature to 120°F during normal power operation, shutdown conditions and "blackout" situations.

9.4.4.1.2 Containment Iodine Removal System (Internal Cleanup)

Two iodine removal units are provided within the containment. Each unit is designed to remove gaseous iodine and particulate radioactivity from the containment atmosphere as required to minimize airborne activity concentrations for containment access during normal operation.

9.4.4.1.3 Rod Drive Ventilation System

Three one-half capacity ventilation fans remove heat continuously from the control rod drive mechanisms during normal power operation. The air flow rate generated by the two operating fans is sufficient to maintain a satisfactory ambient temperature around the electromagnetic positioning coils of the rod drive mechanisms.

9.4.4.1.4 Reactor Nozzle Support Ventilation System

The four reactor nozzle supports are cooled by two sets of two fans. Each pair of full capacity fans cools two of the four nozzle supports. This system operates during normal power operation to assure that concrete surfaces in contact with the structural steel supports do not exceed the design temperature of 150°F. The fans are powered from the Standby AC Power System to cool the concrete during a loss of offsite power.

9.4.4.1.5 Reactor Shield Ventilation System

Two 100-percent capacity fans provide continuous ventilation for the reactor cavity to assure that the ambient temperature within the shield and around the neutron monitoring instrumentation cables does not exceed the design value of 135°F during normal power operation. The fans are powered from the Standby AC Power System to provide reactor cavity cooling during a loss of offsite power.

The air delivered by the Reactor Shield Ventilation System is exhausted primarily through the Reactor Nozzle Support Ventilation System, with the balance of the air forced up and out of the cavity.

9.4.4.1.6 Pressure-Vacuum Relief System

The Pressure-Vacuum Relief System is a normally isolated system which can be used during power and hot standby operations as required to maintain containment pressure in the range of -1.5 to +0.3 psig. One exhaust effluent filter unit and one supply air filter unit are connected to a common penetration to relieve containment pressure or vacuum during normal power operation. The supply air filter unit can be manually energized in the event of a negative pressure in the containment. The exhaust filter unit can be manually energized for pressure relief if the containment pressure exceeds the ambient pressure. All exhaust is directed to the plant vent where it is monitored to assure that releases to the environment are within the limits specified in 10CFR20. The design pressure differentials inherently provide the motive power to restore the containment to an equilibrium pressure. Therefore, no fan power is provided in the system.

9.4.4.1.7 Containment Purge System

The Containment Purge System is normally isolated. One supply air penetration and one exhaust penetration are provided for purging

the containment atmosphere during normal plant shutdown. Purging refreshes the containment atmosphere as required to maintain doses to operating personnel within acceptable limits during shutdown maintenance and/or inspections.

All exhaust is directed to the plant vent where it is monitored to assure that releases to the environment are within the limits specified in 10CFR20. One pair of supply and exhaust fans and filters is normally available in the Auxiliary Building Ventilation System to perform the containment purging functions.

9.4.4.2 System Description

9.4.4.2.1 Fan Cooler Units

The information is presented in Section 6.2.2.2.

9.4.4.2.2 Containment Purge System

The Containment Purge System is a normally closed, deactivated system that is manually energized as required to perform the functions described in Section 9.4.4.1. The supply and exhaust air equipment used for the various purging modes are the standby fan and filter units installed in the Auxiliary Building Ventilation System.

Purging air is supplied by one 35,000-cfm unit consisting of fan and motor, hot water heating coil, 80-percent efficiency filters, shutoff dampers, controls and instrumentation, and a supply duct.

The heating coil is designed to temper the air during winter to 60°F maximum. A low limit temperature alarm is provided in the Control Room to alert the operator in the event the supply air temperature approaches the freezing point. A pneumatically operated, quick-closing, butterfly-type isolation valve is installed outside the containment wall. The valve is designed to withstand the 47 psig, 271°F atmosphere following a design basis LOCA and to close automatically on a safety injection signal or on a high radiation signal from the radiation monitoring devices discussed in Section 11. The filters remove most of the atmospheric dust and dirt that would otherwise enter the containment.

Purging air is exhausted by energizing the 35,000-cfm capacity standby exhaust fan and a standby HEPA filter unit, which are normally available in the Auxiliary Building Ventilation System. Operation of the standby fan in addition to two other 35,000-cfm exhaust fans provides the dual capability of purging the containment and exhausting the Auxiliary Building. The output of each exhaust fan is controlled such that the rate of containment purging can be varied from 0.57 to 0.80 air changes per hour as required, while maintaining the Auxiliary Building at design conditions. The HEPA filters remove 99 percent of particles 0.3 micron and larger from the containment exhaust and are preceded by roughing filters to prolong the life of the HEPA filters.

A 24,000-cfm capacity charcoal filter unit on standby in the Auxiliary Building Ventilation System can be placed in series with the containment purging HEPA filter exhaust unit. The charcoal filter is designed to absorb gaseous contaminants, particularly iodine, and when in use will afford a purging rate of 0.57 air changes per hour. During a reactor shutdown period when a different HEPA filter exhaust unit is available in the Auxiliary Building System for containment purging, but without the charcoal filter, the purging rate can be increased to 0.80 air changes per hour.

The purging exhaust duct that penetrates the containment is provided with an isolation valve as described previously in this section for the purging supply duct.

The exhaust air is combined with the Auxiliary Building exhaust air and directed to the plant vent where the total flow is monitored for radiation.

All penetrations, exhaust equipment, and exhaust ductwork are designed to Class I (seismic) criteria. All supply equipment and supply ductwork are Class II (seismic) design. Purging system compliance with Branch Technical Position (BTP) CSB 6-4 is discussed in Section 9.4.4.3.2. The seismic design and analysis methodologies used to qualify all ductwork and the contained equipment are described in Section 3.8.4.4.1.

9.4.4.2.3 Pressure-Vacuum Relief System

The Pressure-Vacuum Relief System is a normally closed deactivated system that is manually energized as required to equalize the containment with outdoor pressure during normal power operation. The system is designed for 2400 cfm capacity.

The exhaust air (pressure relief) filter unit consists of roughing, HEPA and charcoal filters, shutoff dampers, backdraft preventer, and a water spray Fire Protection System for the charcoal filters.

The HEPA filters are designed to collect not less than 99 percent of particles 0.3 micron and larger, while the charcoal filters are designed to absorb not less than 90 percent of gaseous iodine.

The supply air (vacuum relief) filter unit consists of 80-percent efficiency filters, shutoff damper and a backdraft preventer. The filters remove most of the atmospheric dust and dirt that would otherwise enter the containment.

The common duct from the containment to the supply and exhaust air filter units is provided with two isolation valves in series, one on each side of the containment wall.

The supply air filter unit is of standard construction. The exhaust air unit and all ductwork are designed and constructed to seismic Class I criteria. Pressure-Vacuum Relief System compliance with BTP CSB 6-4 is discussed in Section 9.4.4.3.2. The seismic design and analysis methodologies used to qualify all ductwork and the contained equipment are described in Section 3.8.4.4.1.

9.4.4.2.4 Containment Iodine Removal System (Internal Cleanup)

The Containment Iodine Removal System consists of two fan and filter units located on Elevation 100 feet of the containment building outside the polar crane wall. Either of the units can be manually energized depending upon the need to reduce the level of particulate and gaseous radioactivity. The level of activity within the containment can be continually monitored by gaseous and particulate air monitors. Neither unit is required to be operated during a design basis LOCA.

Each 8,000-cfm capacity iodine removal unit is comprised of a single speed fan, roughing, HEPA and charcoal filters, shutoff dampers, and a water spray Fire Protection System for the charcoal filters. The HEPA filters are designed to collect 99 percent of particles 0.3 micron and larger, while the charcoal filters are designed to adsorb 90 percent of the gaseous iodine. Source air to each iodine removal unit is supplied through a duct connected to the large duct header of the Fan Cooler System.

All equipment and materials comprising the Containment Iodine Removal System are designed and constructed to satisfy Class II seismic criteria. The seismic design and analysis methodologies used to qualify all ductwork and the contained equipment are described in Section 3.8.4.4.1.

9.4.4.2.5 Control Rod Drive Cooling

Control rod drive cooling is performed by the Rod Drive Ventilation System, which consists of three one-half capacity fans

connected to the Control Rod Drive Ventilation System ducts which are integral to the Integrated Head Assembly (IHA). The CRDM ventilation system fans are located on the IHA above the missile shield. Two of the three 34,500 acfm (@ 120°F) fans operate during normal power operation to remove 2.6 x 10^6 Btu/hr from the control rod drive mechanism and discharge the heat above the operating floor (approximate Elevation 130 feet). This heat is then removed from the containment by the cooling coils in the Fan Cooler System.

9.4.4.2.6 Reactor Vessel Cooling

Cooling of the reactor vessel is performed by the Reactor Shield Ventilation System in conjunction with the Reactor Nozzle Support Ventilation System. Both systems can be powered by the Standby AC Power System, and are designed to Class II seismic criteria. The seismic design and analysis methodologies used to qualify all ductwork and the contained equipment are described in Section 3.8.4.4.1.

The Reactor Shield Ventilation System consists of two 100-percent capacity 18,000-cfm fans located outside the polar crane wall at Elevation 100 feet, each with its own duct system. The fans draw filtered, cooled air from the large duct header of the fan cooler system and deliver it to the neutron monitoring instrumentation cable space under the reactor. The system is designed to maintain the cable space at 135°F or less, provide 16,000 cfm through the annular space around the reactor to the Reactor Nozzle Support Ventilation System, and provide 2,000 cfm upward to the reactor head.

The Reactor Nozzle Support Ventilation System consists of two identical subsystems, each comprised of two 8,000-cfm fans (one spare) connected to common ductwork embedded in the reactor shield to cool two of the four reactor nozzle supports. The system draws air from the annular space around the reactor and through each of the nozzle supports to maintain the concrete bearing surfaces at

150°F or less. Source air is supplied to the annulus by the Reactor Shield Ventilation System. All fans are located outside the reactor shield on floor Elevation 81 feet and discharge in the vicinity of the steam generators.

9.4.4.2.7 Penetrations

Ventilation duct penetrations in the Containment Building are equipped with pneumatically operated, quick closing, butterfly-type isolation valves. Each isolation valve is part of a sealed penetration assembly, designed to Class I seismic criteria, to withstand the 47 psig, 271°F, saturated steam-air mixture resulting from a design basis LOCA. Complete closure of at least one valve at each penetration satisfies containment isolation or closure criteria. The seismic design and analysis methodologies used to qualify all ductwork and the contained equipment are described in Section 3.8.4.4.1.

All ventilation isolation valves that require remote-manual actuation to open are of the fail-closed type. The valve operator is a dual acting (except for the pressure-vacuum relief valves, which are single acting/spring return), piston-type, pneumatic operator, controlled by a solenoid-type air supply valve.

In the event of a loss of control air pressure and/or electric control power, a spring assembly integral with each isolation valve is designed to return the valve to the closed position.

Each ventilation isolation valve is equipped with a permanently bonded rubber seat (except 1VC5 and 1VC6 which have hard metal seats) for the butterfly disc, and low leakage bushings on the butterfly shaft. This construction limits leakage from each valve to 5.0 cc per hour per inch of valve diameter when subjected to 47 psig saturated steam in the closed position.

9.4.4.2.8 Instrumentation and Control

Instrumentation and controls for starting, stopping and monitoring the performance of the Containment Ventilation System are located

in the Control Room. Additional instrumentation is also provided locally for inspection, test and maintenance.

The instrumentation and controls provided in the Control Room include the following:

1. START and STOP pushbuttons for fans and fan coolers.

2. Low air flow alarms.

3. OPEN-CLOSE indication for the air control dampers in each fan cooler. (The normal positioning of the dampers is interlocked with the starting of the fan at its higher speed, while the post-accident positioning of the dampers and the lower fan speed are interlocked with a safety injection signal.)

4. High differential air pressure alarms for filters.

5. High temperature alarms for the fan cooler motor bearings and windings, air leaving each fan cooler, air discharged from the control rod drive mechanisms and reactor nozzle supports, ambient air around the neutron monitoring instrumentation cables, and the ambient air at numerous locations throughout the containment.

6. Control equipment to manually select ventilation filtration paths and service water isolation valve position indicating lights. (Ventilation duct isolation valves are interlocked to close automatically on a safety injection signal or in the event of a high radiation signal from the containment.

7. Service water temperature and flow indication.

8. Fire alarms to signal any ignition of a charcoal filter bank. (The ignition detection automatically actuates a water deluge system for the affected charcoal filter.)

9. High radiation alarms for service water leaving the fan coolers. These monitors are located outside the containment.

10. An overhead annunciator alarm is received whenever containment ventilation isolation is reset in the presence of an isolation actuation signal.

The instrumentation provided locally includes the following:

1. Manometers for indication of pressure drop across each bank of HEPA and charcoal filters, and each bank of roughing filters outside the containment.

2. Position indicators for each air control damper, water control valve, and isolation valve.

3. Pressure test-taps or gages in service water lines to each water cooled fan motor in the Fan Cooler Safeguard System.

9.4.4.3 Design Evaluation

9.4.4.3.1 General

During the final design review of Unit 2 the Nuclear Regulatory Commission requested verification that adequate torque was available to shut isolation valves in the Containment Vacuum Relief and Purge System. Public Service Electric & Gas evaluated this matter based on a conservatively assumed differential pressure of 60 psi, and it was determined that the actuator torque values were not sufficient to move the valves from the full open (90°) position to the closed position (0°). With a differential

pressure of between 18 to 24 psi, which is the calculated actual differential, the actuator torque values were marginal. Corrective action was therefore taken as follows:

1. For the 36-inch purge valves, administrative controls were implemented to keep the valves closed in all operating modes except cold shutdown and refueling.

2. The 10-inch valves were modified by the vendor. The modification consisted of reworking the actuator and a realignment of the actuator and valve shaft such that the full open position will correspond to 60° open instead of the original 90° open. This significantly reduced the required closing torque with a 60 psi differential to a value well below the available actuator torque. The new required closing torque with a 60 psi differential is 4,572 in-lbs, whereas the actuator torque available is 9,100 in-lbs, (spring force only, with no air assist).

Detailed valve information is contained in correspondence dated February 18, 1982 (Liden to Varga).

The Containment Fan Cooler System is required to remove Heat from the containment atmosphere to limit the average containment temperature during normal operation within design limits. A maximum of four out of the five units installed operate in high speed to recirculate, filter and cool the containment atmosphere during normal operation. Additional evaluation is presented in Section 6.2.2.2.

The design of all the other mechanical Ventilation Systems within the containment (iodine removal, reactor shield ventilation, reactor nozzle support ventilation, and control rod drive ventilation) includes at least one standby unit with its own power, controls and instrumentation. Physical separation and redundancy of the power and control sources enhances the

reliability of these systems. The failure of a single component or unit, therefore, will not prevent these systems from performing their design function. Additionally, the design operating capacity of the Reactor Shield, Reactor Nozzle, and Rod Drive Ventilation Systems exceeds the minimum performance requirements.

Ventilation ductwork penetrating the containment consists of two 36-inch diameter ducts for containment purging and one 10-inch diameter duct for containment pressure-vacuum relief. Isolation valves in each duct, at each containment penetration, assure valve closure to prevent the release of radioactivity from the containment environment. Each of the isolation valves is designed to withstand the effects of any LOCA accident. Failure of a single component or unit will not prevent these isolation valves from performing their function.

The control rod drive mechanism (CRDM), reactor vessel supports and the out-of-core nuclear instrumentation are provided cooling air by separate, independently controlled ventilation systems. They are the Rod Drive Ventilation System (Section 9.4.4.2.5), Reactor Nozzle Support Ventilation System and the Reactor Shield Ventilation System (Section 9.4.4.2.6).

Loss of cooling air to the CRDMs, the vessel supports, or the nuclear instrumentation will be detected via high air temperature alarms and/or low air flow alarms for the respective ventilation systems serving this equipment. Temperature and flow instrumentation is provided for each of the Ventilation Systems as shown on Plant Drawings 205238 and 205338. An alarm is annunciated in the Control Room on indication of low airflow or high air temperature for an individual vent fan unit of the Ventilation Systems. The operation of the vent fan units (start-stop) is also monitored in the Control Room.

The CRDM coils have a design operating temperature of 392°F. Should this temperature be exceeded over a period of time, the

life of the mechanism coils would be affected. The reactor vessel support concrete surfaces have a design operating temperature of 150°F. The out-of-core nuclear instrumentation and cabling have a design operating temperature of 135°F. The Containment Ventilation Systems have been designed with spare capacity fans, physical separation, and redundant power and control sources so that a single component or unit failure will not affect the operation of these systems and ensure that these design temperatures are not exceeded.

An average ambient temperature of 120°F in the containment is maintained by the containment fan coolers. Under normal conditions, two of the three rod drive vent fans operating will maintain the temperature of the CRDM coils below 392°F and the CRDM ventilation fan outlet temperature below 160°F. The reactor vessel supports will have sufficient cooling air from two of the four reactor nozzle support fans (one from each pair) so that the design temperature of 150°F is not exceeded. The operation of one of the two reactor shield vent fans will keep the out-of-core instrumentation below the design operating temperature of 135°F. The temperature alarms will annunciate when the normal operating temperatures are exceeded.

The Ventilation System alarms will warn the operator if the cooling air for the CRDMs, reactor vessel supports, or the out-of-core instrumentation areas has exceeded the temperature limits or do not have sufficient cooling air flow. The operator will then manually actuate the spare fan units for the affected system. These actions should restore normal cooling air flow and temperatures to the above-mentioned equipment and areas and return the alarmed condition to normal.

It is considered highly unlikely that a complete loss of cooling air from the Containment Ventilation Systems would occur because of the system design and use of multiple fans. In the unlikely event that high temperature and/or low air flow alarms are annunciated and the spare capacity fans and coolers are incapable of supplying the required ventilation to maintain design

conditions, the plant will be shut down to prevent equipment damage and to effect repairs to the ventilation systems.

9.4.4.3.2 Conformance to Branch Technical Position CSB 6-4

This section addresses conformance of Containment Purge and the Pressure-Vacuum Relief Systems to BTP CSB 6-4. The item numbers below correspond to the numbering used in Section 5 of CSB 6-4:

1a. The purge line isolation valves were purchased, manufactured and factory tested prior to the issuance of the NRC BTP MEB-2, "Pump and Valve Operability Assurance Program." The pressure-vacuum relief line isolation valves have been replaced and meet the intent of NRC BTP MEB-2. The appropriate design, environmental and leakage parameters were adequately specified for these isolation valves. The valves have undergone testing to verify leak tightness and operability during seismic events. The appropriate quality documentation was provided for the valves. The valves will be tested periodically for operability and leakage in accordance with the Technical Specifications. Although not specifically referenced, the design and testing of the purge and pressure-vacuum relief isolation valves meet the intent of BTP CSB 6-4.

1b. Each unit has two purge lines and one pressure-vacuum relief line penetrating the containment.

1c. The purge vent lines are 36 inches in diameter and the pressure-vacuum relief line is 10 inches in diameter. The 36-inch lines, however, are not used for routine station operation. The operability of the 10-inch pressure-vacuum relief valves was assessed with respect to the stresses induced by the valve-to-operator interfacing hardware under operating loads during a LOCA. This analysis demonstrates that the 10-inch pressure-vacuum relief valves (VC5 and VC6) will operate in the event of a LOCA. Technical Specifications allow

the valves, normally maintained shut in Modes 1, 2, 3, and 4, to be intermittently opened under administrative control for safety purposes during all applicable modes of operation. The accident analysis (see item 5a, below) yields doses well within 10CFR50.67 guidelines.

1d. The isolation valves and control system provisions for isolation meet the appropriate safety-related criteria consistent with containment isolation. Containment Purge System isolation is actuated by Phase A and high radiation signals.

1e. Instrumentation and Control Systems are independent and actuated by diverse parameters.

1f. The purge and pressure-vacuum relief isolation valves are designed to close within 2 seconds. The valves were tested at the factory and will be tested periodically in accordance with the Technical Specifications. Total isolation time, including the 2-second valve closure, will not exceed 5 seconds if initiated by a high containment pressure signal (based on a design basis double-ended cold leg rupture). Isolation time will not exceed 10 seconds if initiated by a high containment radiation signal. Isolation is also initiated by a safety injection signal.

1g. To ensure isolation valve closure, the design, which includes the type, location, orientation, and configuration of valves and piping/ducting of the Penetration and Ventilation System, considers the potential problem of debris becoming entrained in the escaping air and steam. Where the containment purge and pressure-vacuum relief penetrations are not connected directly to a filtered ventilation system and are terminated in the free containment atmosphere, the openings are faced down to preclude debris from entering

the system. All the valves are either contained within the piping/duct lines or have a 1-inch expanded metal mesh basket around them.

2. The Containment Purge System is not intended for humidity and temperature control within the containment, but was designed to perform the functions previously described.

3. The Containment Ventilation System utilizes fan coolers for temperature and humidity control. The Iodine Removal System (internal cleanup) is used to remove gaseous iodine and particulate activity from the containment atmosphere.

4. The isolation valves are testable for operability and leakage in accordance with the Technical Specifications.

5a. The dose analysis for a LOCA during containment pressure relief is presented in Section 15. This analysis utilizes very conservative assumptions, including an iodine spike. The analysis results in doses well within 10CFR50.67 guideline values.

5b. The system design includes provisions to protect structures and safety-related equipment. All equipment necessary to perform automatic isolation of the containment purge and pressure-vacuum relief lines is external to the containment (except the inboard isolation valves) and would not be affected by a LOCA.

5c. The analysis of a double-ended pipe rupture (see Section 15) indicates less than 0.2 percent of the Reactor Coolant System mass would be released from the containment prior to isolation. This will not adversely affect Emergency Core Cooling System performance.

5d. The allowable leak rate is specified in the Technical Specifications.

Based on the above, it is concluded that the design of the Containment Purge and Pressure-Vacuum Relief Systems satisfies the requirements of BTP CSB 6-4.

9.4.4.4 Tests and Inspections

All components of the Containment Ventilation System are subjected to a test and inspection program. The performance of unitized equipment, such as fans, filters, cooling coils, isolation valves, dampers, etc., is verified through manufacturers' tests and inspections. The performance of field-erected sections, such as filter enclosures and duct work, is verified mainly through post-erection tests and inspections. After installation, all unitized equipment and field-erected sections are inspected, tested and adjusted to assure performance of their design function. During plant operation, periodic tests and inspections are performed to ensure the integrity and performance of all components. All components are inspected when delivered to the site to assure compliance with specifications.

All components of the Containment Fan Cooler System are designed to withstand normal and LOCA conditions without loss of function. When it is impractical to subject components to full scale testing, conservative calculations and/or prototype tests are performed to demonstrate capability to resist LOCA and seismic effects.

The Pressure-Vacuum Relief System for the Containment Building is expected to be used intermittently during normal operations. When operated, the system will maintain containment internal pressure between 0.3 psi positive and 1.5 psi negative.

Station personnel can read local manometers at the equipment during system startup to see if filter pressure drops are approaching their design limits. Also, a sample of the charcoal filter will be available in the pressure relief unit for removal and testing to determine the efficiency of the charcoal filter.

9.4.5 Diesel Generator Area Ventilation

9.4.5.1 Design Bases

The Ventilation Systems are designed to limit the temperature of each diesel generator compartment to 120°F and each Control Room to 110°F in the summer with equipment in the room operating. The unit heaters are designed to limit the temperature in the rooms to 60°F minimum in the winter. This range of room temperature (60°F to 110°F or 120°F) is an adequate environment for reliable operation and maintenance of the diesel generator, its controls and instrumentation.

The ventilation capacity for each diesel generator compartment (40,000 cfm) and Control Room (1,200 cfm) is based on the waste heat released to the space. The ventilation capacity for the fuel oil storage area (2,800 cfm) provides 5 air changes per hour.

The ventilation equipment and controls for the diesel generator compartments and Control Rooms can be powered from the Standby AC Power System and is designed to seismic Class I criteria. The fuel oil storage area ventilation is powered by the Normal AC Power System and is designed to seismic Class II criteria. The seismic design and analysis methodologies used to qualify all ductwork and the contained equipment are described in Section 3.8.4.4.1.

9.4.5.2 System Description

9.4.5.2.1 General Description

The Diesel Generator Area Ventilation System is shown on Plant Drawings 205321 and 205322. The diesel generator area for each plant consists of three diesel generator compartments, three diesel generator Control Rooms and a fuel oil storage area. Each of these spaces is provided with an independent, once-through ventilation system. The use of independent systems enhances the effectiveness of the Carbon Dioxide Flooding System in the event of a fire, permitting selective flooding into a given space without affecting other spaces. In the event carbon dioxide is delivered to a space, the ventilation for that space is automatically terminated.

The diesel generator compartment Ventilation Systems are designed to start automatically and limit the maximum room temperature when the diesel generators are operating. Provisions are available to permit starting or testing individual systems during normal plant conditions when the diesel generators are not running.

The Control Room Ventilation Systems are normally placed in air automatic mode. In this mode, a local thermostat for each room provides on-off control of its supply fan to regulate temperature. A local ON-AUTO-OFF switch is provided to permit manual operation of the fan.

The ventilation system for the fuel storage area is also normally placed in an automatic mode. In this mode a local thermostat provides on-off control on the exhaust fan to regulate the space temperature. A local ON-AUTO-OFF switch is provided to permit manual operation of the fan.

The Diesel Generator Area and Diesel Generator Control Room ventilation systems both consist of 1) a supply fan bringing outdoor air into the building and 2) supply air ductwork which directs the supply air into the environmental spaces.

The Ventilation System for the fuel storage area consists of 1) an exhaust fan discharging to the outdoors and 2) a supply air duct which supplies outdoor air to the room.

Local unit heaters assure an adequate minimum temperature in the spaces during cold weather.

9.4.5.2.2 System Operation

The Diesel Generator Area, Diesel Generator Control Room and Fuel Oil Storage Area ventilation systems are all normally operated in an automatic mode. The Control Room and Fuel Oil Storage Area ventilation fans are controlled (on-off) by local thermostats to regulate the environmental space temperatures. The Diesel Generator Area ventilation fans are energized only when the diesel generators are started. All of these Ventilation Systems can be started independently, however, for testing and maintenance.

THIS PAGE INTENTIONALLY BLANK

The Diesel Generator Area Ventilation system utilizes a single-speed supply fan to direct outdoor air to the Diesel Generator engine room through supply air ductwork. The air is exhausted through openings in the ceiling of the engine room into the silencer area and is then exhausted outdoors through roof mounted penthouses. Temperature regulation for this area is accomplished through thermostatically controlled modulating dampers which regulate the volume of incoming outdoor air and recirculated indoor air.

The Diesel Generator Control Room ventilation system utilizes a single-speed supply fan to direct outdoor air to the control room through supply air ductwork. The air is exhausted to the outdoors through a roof mounted penthouse. Temperature regulation for the control room is accomplished through thermostatic, on-off control of the supply fan.

The fuel oil storage area utilizes a single-speed exhaust fan which discharges to the outdoors. Supply air is drawn into the area from the outdoors through supply ductwork. Temperature regulation for this area is accomplished through thermostatic, on-off control of the exhaust fan.

Each system will automatically shut down if carbon dioxide fire protection flooding is initiated for the space.

If the ambient temperature in a diesel generator compartment or Control Room exceeds 110°F or goes below 40°F, the condition is alarmed in the Unit Control Room.

9.4.5.3 Design Evaluation

The heating and ventilating of the diesel generator area is predicated on outdoor temperature limits of 0°F in winter and 95°F in summer. For the Salem site, these values satisfy more than 99 percent of the conditions experienced annually. There is, therefore, a conservative margin in the heating and ventilating systems to assure that the design temperatures for the spaces can be maintained. Heaters are provided in the Lube Oil System and in the Jacket Water System to assure each diesel generator is maintained at a temperature at which it can be started in 13 seconds. This condition is satisfied for an outside temperature of 0°F and an inside ambient temperature of 40°F.

The Ventilation Systems for the diesel generator areas are independent, physically separated and powered from separate sources. Each system is provided with its own controls.

In the event of a fire in one space, the Ventilation System for that space is automatically de-energized and does not feed air to the fire. The other diesel generators are available with full ventilation.

The CO_2 system contacts, that interpose the ventilation systems, are bypassed by the operation of switches in the Control Room if a station seismic event is detected.

9.4.5.4 Tests and Inspections

All equipment and components of the diesel generator area Ventilation Systems are subject to a program of tests and inspections.

9.4.6 Switchgear and Penetration Area (SPAV) Ventilation System

9.4.6.1 Design Basis and Criteria

The Switchgear and Penetration Area Ventilation (SPAV) System is designed to maintain safe levels of temperature and cleanliness in the rooms served. Standby equipment is included in the system to assure the maintenance of these design conditions. The system is seismic Class I. The seismic design and analysis methodologies used to qualify all ductwork and the contained equipment are described is Section 3.8.4.4.1. The Ventilation System is designed to maintain the areas served by this system between a temperature range of 65°F-110°F except for the following areas:

El. 64' Security Battery Room	115°F
El. 64' Elevator Machinery Room	(SEE NOTE)
El. 84' Main Corridor	115°F
El. 84' Unit 1 Switchgear Room	115°F

NOTE: Not applicable, no safety related equipment in this area.

The design basis outdoor air temperature is 0°F (winter) and 95°F (summer). A 10°F daily temperature variation may be used for summer operations, in accordance with ASHRAE methodology. These temperature values satisfy more than 99 percent of the conditions experienced at the site area annually.

9.4.6.2 System Description

9.4.6.2.1 General Description

An independent Ventilation System is provided for each unit's Switchgear Rooms which are located on Elevations 84 feet and 64 feet, Mechanical Penetration Area (El. 100'), and the Electrical Penetration Area (El. 78') of the Auxiliary Building. The SPAV System consists of a supply air roll filter and enclosure, three supply air fans, two Penetration Area exhaust fans, two return/exhaust fans, recirculation duct, supply and exhaust ducts, and control dampers. Most of the equipment is located in the penetration areas at Elevation 100 feet of each unit. All ventilated areas and equipment are enclosed in seismic Class I structures. The Switchgear Ventilation System is shown on Plant Drawings 205248 and 205348.

9.4.6.2.2 System Operation

The Ventilation System for each unit consists of the following equipment:

1. One 100-percent capacity supply-air filtering unit having 70-82 percent ASHRAE weight arrestance efficiency to filter the outside and recirculated air.

2. Three 50-percent capacity fans to supply filtered air through supply ducts to the various areas.

3. Two 100-percent capacity return/exhaust air fans to either exhaust air out of the switchgear rooms or return air for recirculation.

4. Two exhaust fans for the Mechanical Penetration Area (Elevation 100 feet) and electrical penetration area (Elevation 78 feet).

5. Three recirculation cooling units serve the north (mechanical) penetration area at Elevation 100 feet, each consisting of a filter, cooling coil and fan.

6. Control and instrumentation.

7. Distribution ductwork and dampers for the supply air, exhaust air or recirculation air.

Normally two of the three supply fans operate with the third fan as a standby. One of the return/exhaust fans operate with the second fan in standby and both of the penetration area exhaust fans operate. Supply temperature will be monitored and outside air intake dampers, recirculation damper, and exhaust damper will modulate to provide relatively constant supply air temperature to all areas of this system.

When the supply air temperature is equal to or above 75°F, the system will be aligned to supply 100% outside air; that is, the recirculation damper closed and the intake and exhaust dampers fully opened.

When the supply air temperature is between 65° and 75°F, the intake dampers, the recirculation damper, and the exhaust damper modulate to temper the supply as required to maintain temperature.

When the supply air temperature is equal to or less than 65°F, both penetration area exhaust fans stop. The two supply fans and the switchgear return/exhaust fan continue to operate at full flow. In this situation, the recirculation damper is 100% open and the outside air intake dampers are 100% closed. By procedure, the access door of the other Unit's SPAV air handling unit housing is opened to equalize pressure in the electrical penetration area and mechanical equipment rooms.

Both switchgear rooms (El. 64' & 84') and electrical penetration area (El. 78') are provided with a fire detection system. If operation of the Fire Protection System for one of these areas is initiated, the supply and exhaust dampers for the affected area close. For the switchgear rooms, the main recirculating dampers close and the system operates as a once-through system supplying 100 percent fresh air. This prevents the tripping of other smoke detectors by recirculated smoky air. The ventilation system also provides a means for purging smoke from the fire area as soon as air supply is re-established.

9.4.6.3 Design Evaluation

The ventilation equipment for the SPAV are enclosed in a seismic Class I structure. The Equipment Room is directly accessible from the Relay Room of the control area. All other areas in the vicinity of the Switchgear Rooms are ventilated by systems which are completely independent of the SPAV System and thus fire and smoke generated in such other areas would not impair the integrity or accessibility of the Switchgear Rooms.

9.4.6.4 Tests and Inspections

The SPAV system is inspected, tested and balanced upon installation. Normal operation serves as a continuous check on system operation.

Operation of the dampers, including those associated with initiation of the Carbon Dioxide Fire Protection System, can be checked periodically.

9.4.7 Service Water Intake Structure Ventilation

9.4.7.1 Design Bases

The Ventilation Systems are designed to limit the temperature of each compartment and/or Control Room to 110°F during ambient conditions of 95°F with all equipment operating. The unit heaters are sized to limit the temperature in the areas to a nominal 60°F in the winter during ambient condition of 0°F. Reliable operation of the service water pumps, their controls and instrumentation is assured for a temperature range of 40°F-110°F.

The ventilation capacity for each service water intake structure compartment and Control Room is based on the calculated waste heat released.

The exhaust fans (12,000 and 32,000 cfm capacity) and their controls and instrumentation are designed to Class I (seismic) criteria and can be powered from the Standby AC Power System. The air intake penthouse, supply and exhaust dampers are of non-seismic construction. The seismic design and analysis methodologies used to qualify all ductwork and the contained equipment are described in Section 3.8.4.4.1.

9.4.7.2 System Description

9.4.7.2.1 General Description

The service water intake structure for both units consists of four service water intake compartments, each with its own Control Room. Each of these compartments is provided with an independent, once-through Ventilation System.

The service water intake structure Ventilation Systems are designed to start automatically and limit the maximum room temperature when the service water pumps are operating.

The Ventilation System for each compartment consists of an outside air intake penthouse, power-operated intake and exhaust dampers, and two exhaust fans discharging to the outdoors.

Local unit heaters assure an adequate minimum temperature in the spaces during cold weather when no pumps are in operation.

9.4.7.2.2 System Operation

The service water intake structure Ventilating Systems operate automatically in response to compartment and/or Control Room temperatures.

The Ventilation Systems operate as follows: on a small rise in temperature, the smaller of two exhaust fans starts and discharges to the outdoors. The supply air from the outdoors is modulated by room thermostats to provide the design compartment or Control Room temperature. On a greater rise in temperature, the larger fan starts, its intake damper opens and more air is induced to flow through the compartments. When a system is shut down, its exhaust fans stop and the supply and exhaust air dampers return by spring action to their closed positions.

Prior to the ambient temperature in compartments or Control Rooms exceeding 110°F or going below 40°F, the condition is alarmed in the Control Room.

9.4.7.3 Design Evaluation

The heating and ventilating of the service water intake structure area is predicted on outdoor temperature limits of 0°F in winter and 95°F in summer. For the Salem site, these values satisfy more than 99 percent of the conditions experienced annually. This is, therefore, a conservative margin in the Heating and Ventilating Systems to assure that the design temperatures for the spaces can be maintained.

The Ventilation Systems for the service water intake structure compartment use two fans which are physically separated and powered from separate sources. Each system is provided with its own controls, can be started manually or automatically, and can be tested independently to assure its availability. Failure of the non-seismic ventilating equipment (dampers and intake penthouse) would not interfere with the ability of the exhaust fans to perform their design function. The dampers fail open or loss of air or electric power.

9.4.7.4 Tests and Inspections

The system is inspected and tested upon installation. Normal operation serves as a continuous check on system operation.

9.4.8 References for Section 9.4

1. USNRC Regulatory Guide 1.183, "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors, July 2000

2. 10 CFR Part 20, Appendix B, Annual Limits on Intake (ALIs) and Derived Air Concentrations (DACs) of Radionuclides for Occupational Exposure; Effluent Concentrations; Concentrations for Release to Sewerage

3. 10 CFR Part 50 Appendix I, Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criteria "As Low as is Reasonably Achievable" for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents

4. 40 CFR Part 190, Protection of Environment, Environmental Radiation Protection Standards For Nuclear Power Operations

5. Salem Units 1 and 2 Offsite Dose Calculation Manual (ODCM)

Figure F9.4-1A intentionally deleted.

Refer to plant drawing 205248 in DCRMS

Figure F9.4-1B intentionally deleted.

Refer to plant drawing 205348 in DCRMS

Figure F9.4-2A Sheets 1, 2 & 3 of 3 intentionally deleted.

Refer to plant drawing 205237 in DCRMS

Figure F9.4-2B Sheets 1, 2 & 3 of 3 intentionally deleted.

Refer to plant drawing 205337 in DCRMS

Figure F9.4-3A intentionally deleted.

Refer to plant drawing 205321 in DCRMS

Figure F9.4-3B intentionally deleted.

Refer to plant drawing 205322 in DCRMS

Figure F9.4-4A Sheets 1, 2 & 3 of 3 intentionally deleted.

Refer to plant drawing 205238 in DCRMS

Figure F9.4-4B Sheets 1, 2 & 3 of 3 intentionally deleted.

Refer to plant drawing 205338 in DCRMS

Figure F9.4-5A intentionally deleted.

Refer to plant drawing 205321 in DCRMS

Figure F9.4-5B intentionally deleted.

Refer to plant drawing 205322 in DCRMS

Figure F9.4-6A intentionally deleted.

Refer to plant drawing 205248 in DCRMS

Figure F9.4-6B intentionally deleted.

Refer to plant drawing 205348 in DCRMS

9.5 OTHER AUXILIARY SYSTEMS

9.5.1 Fire Protection

9.5.1.1 Fire Protection Program

The Salem Generating Station Fire Protection Program has been established to prevent significant fires, to ensure the capability to shutdown the reactors and maintain them in a safe shutdown condition, and to minimize radioactive releases to the environment in the event of a significant fire. The fire Protection Program implements the philosophy of defense-in-depth protection against the hazards of fire and its associated affects on equipment important to safety by:

1. Preventing fires from starting.

2. Rapidly detecting, controlling, and promptly extinguishing those fires that do occur.

3. Providing protection for structures, systems, and components important to safety so that a fire that is not promptly extinguished by the fire suppression activities will not prevent the safe shutdown of the plant.

The Salem Generating Station Fire Protection Program consists of design features, equipment, personnel, and procedures that provide defense-in-depth protection of the public health and safety. The Salem Fire Protection Program is described in several documents:

- A program description which establishes the basis for the fire protection program at the Salem Generating Station. The program description identifies and documents principal fire protection commitments made between the Nuclear Regulatory Commission and PSEG through a narrative description of the Fire Protection Program. The report also provides a comparison to Appendix A of BTP APCSB 9.5-1.

- A report which establishes the basis for demonstrating a capability to achieve and maintain post-fire safe shutdown in accordance with Appendix R to 10 CFR 50. This report also establishes the information and format of the information to be utilized for long-term compliance to Appendix R to 10 CFR 50.

- A report which identifies the cables and the routing of the cables that were utilized in the assessment of post-fire safe shutdown.

- A report which outlines the Fire Hazards Analysis performed for Salem Generating Station in accordance with USNRC Branch Technical Position BTP-APCSB 9.5-1 Appendix A "Guidelines for Fire Protection for Nuclear Power Plants" and defines fire area boundaries.

The information contained in these reports is summarized in the following sections.

9.5.1.1.1 Organization for Fire Protection

The President & Chief Nuclear Officer is the upper level management position who has management responsibility for the formulation, implementation, and assessment of the effectiveness of the Fire Protection Program for the Nuclear Business Unit.

The Director, Engineering Services is the management position who is responsible for formulating and implementing a program or programs to control and maintain the design aspects of the Fire Protection Program.

The Director, Corporate Operations is the management position responsible for formulating and implementing a program or programs to control and maintain fire prevention aspects of the Fire Protection Program and the readiness to detect and suppress fires and safely shut down the plant. The Director, Corporate Operations is also responsible for establishing a method of tracking and correcting Fire Protection Program deficiencies; establishing program requirements for implementing the aspects of the Fire Protection Program relative to fire prevention and housekeeping, readiness to detect and suppress fires, and a trained fire brigade; and ensuring any required maintenance of fire protection systems is completed promptly and effectively.

The fire brigade responds to the respective (plant) Shift Manager during plant emergencies.

The Plant Manager is responsible for maintaining procedures for safely shutting down the plant in the event of a fire and providing trained operators in support of safe shutdown and fire brigade activities.

The Plant Manager is responsible for ensuring that personnel designated to operate the plant are trained such that they can safely shut down the plant and maintain it in a safe shutdown condition in the event of a fire.

The Director-Nuclear Oversight (NOS) is responsible for defining a QA program for fire protection and for conducting independent verification and review for compliance with Fire Protection Program requirements.

9.5.1.1.2 Use of Combustible Materials

The use of combustible materials at the Salem Generating Station is controlled by station procedures. Administrative controls are established to minimize the quantity of combustibles 1) in safety related areas, 2) in areas that present an exposure to safety related equipment, and 3) in areas designated as combustible control zones.

Procedures outline the methods to be used to ensure safe handling and limitations on the use of combustibles.

The use of ordinary combustibles such as paper, wood and plastic is minimized in the station. When wood is used for scaffolding, it is of the flame retardant type.

The bulk storage of hydrogen is in a separate area, outside plant structures. Additional hydrogen storage is in the Turbine Building and on the Auxiliary Building Roof. Signs are posted in the storage areas prohibiting smoking, open flames, and spark producing equipment.

Bulk Class A materials, such as charcoal filter medium, are not stored in safety related areas of the station.

Bulk quantities of flammable liquids are not stored at Salem. Combustible liquids stored in buildings containing safety related equipment are limited to the Diesel Generator Fuel Oil Storage Tanks and Day Tanks.

Each Diesel Generator Day Tank is located in a concrete enclosure and is protected by a manual CO_2 flooding system. The tanks are vented to the outside and the vents are equipped with flame arresters.

Each diesel Generator Fuel Oil Storage Tank is located in a separate room enclosed by fire barriers. The tanks are vented to the outside with provisions to prevent overpressurization. Each tank is located in an enclosure that is designed to hold the entire volume of the tank.

Chemicals are stored in the primary and secondary water chemistry laboratories. The quantities of chemicals stored in the labs are minimal, and are stored in metal cabinets.

9.5.1.1.3 Control of Ignition Sources

Procedures are established to ensure safe operating practices whenever hot-work operations are performed. Hot-work permits and fire watches are required to protect safety related equipment from fire damage or loss resulting from work involving ignition sources, welding, cutting, grinding, and open flame type work. Procedures also prohibit the use of open flame or combustion smoke for ventilation leak testing that presents a potential ignition source.

Smoking is prohibited in vital plant areas.

9.5.1.1.4 Testing and Maintenance of Fire Protection Systems

The Salem Generating Station suppression and detection systems are periodically tested in accordance with station procedures to verify their operability. Systems that do not satisfy acceptance criteria are restored to operable condition in a timely fashion. As specified in Generic Letters 86-10 and 88-12, fire protection system requirements were removed from the Salem Technical Specifications after the FSAR was updated to incorporate the Fire Protection Program. The limiting Conditions for Operations and Surveillance Requirements formerly contained within Technical Specifications have been incorporated into Administrative and Surveillance Procedures respectively.

9.5.1.1.5 Quality Assurance Program for Fire Protection

The Quality Assurance Program at Salem Generating Station assures that the requirements for design, procurement, installation, testing, and administrative controls for the fire protection program for safety related areas are satisfied.

The QA program for fire protection is part of the overall station QA program and contains the following elements:

DESIGN CONTROL AND PROCUREMENT DOCUMENT CONTROL

Design control and procurement document control measures are established to assure that applicable NRC guidelines are included in design and procurement, and that design changes and deviations are adequately reviewed and approved.

INSTRUCTIONS, PROCEDURES, AND DRAWINGS

Instructions, procedures, and drawings govern the fire protection program of inspection, tests, administrative controls, fire drills, and training.

CONTROL OF PURCHASED MATERIAL, EQUIPMENT AND SERVICES

Control of purchased material, equipment, and services are established to assure that these items conform to procurement documents.

INSPECTIONS

A program for the inspection of activities affecting fire protection is established to verify conformance to documented installation drawings and test procedures.

TEST AND CONTROL

A test program is established to ensure that testing is performed and verified by inspection and audit to demonstrate conformance with fire protection requirements.

INSPECTION, TEST AND OPERATING STATUS

Inspection, test, and operating status measures are established to provide for the identification of items that have satisfactorily passed required tests and inspections.

NONCONFORMING ITEMS

Measures are established to control items that do not conform to specified requirements to prevent inadvertent use in fire protection installations.

CORRECTIVE ACTION

Corrective action measures are established at the station to ensure that conditions adverse to fire protection such as failures, malfunctions, deficiencies, deviations, defective components, uncontrolled combustible materials, and non-conformances are promptly identified, reported, and corrected.

RECORDS

Records are prepared and maintained to furnish evidence that the QA program criteria are being met for those activities affecting the fire protection program.

AUDITS

Audits of activities affecting quality are performed by the Nuclear Oversight Department.

9.5.1.1.6 Fire Brigade

The Salem Fire Brigade consists of full time dedicated fire fighting personnel with a minimum of five trained fire fighting personnel onsite at all times with provisions for a 2-hour call out to cover emergency absences. At least three of the on-shift fire brigade members are knowledgeable in Salem's safety systems to understand the effects of fire and fire suppressants on safe shutdown capability.

9.5.1.1.7 Fire Brigade Training and Drills

The fire brigade training program ensures that the capability to fight potential fires is established and maintained. The program consists of classroom training, fire fighting practice, and fire drills.

The fire brigade training is provided by individuals who are knowledgeable and qualified by previous training, and experienced in the use of available equipment and in fighting the fires that could occur at the Salem Station.

9.5.1.1.8 Fire Drills

Fire brigade drills are conducted quarterly for each fire brigade shift. The drills are conducted in areas where simulated fires of the type, size, and arrangement that could reasonably occur and develop during the response and organization time of the fire brigade. Drills are conducted so that each fire brigade member can participate in each drill, but must participate in at least two drills per year. At least one drill per year is held on the back shift. At least one drill per year is unannounced.

An engineer who is qualified as Member Grade in the Society of Fire Protection Engineers and who is not an employee of PSEG, critiques a randomly scheduled unannounced drill. This drill is conducted at 3 year intervals as part of the Triennial Fire Protection Program audit and inspection.

9.5.1.1.9 Fire Brigade Equipment

The fire brigade is provided with complete personal protective gear, emergency communication equipment, portable lights, portable ventilation equipment, and self contained breathing units.

9.5.1.1.10 Off-Site Fire Department

Training of the plant fire brigade is coordinated with the local fire department to ensure that the responsibilities and duties of the brigade and the offsite fire departments are delineated in advance of any fire.

9.5.1.2 Plant Construction Features

9.5.1.2.1 Fire Areas and Barriers

Fire areas are established to separate redundant trains of safe shutdown equipment from each other, to isolate safety-related systems from fire hazards in non-safety related areas, to separate Salem Unit 1 from Salem Unit 2 and to limit the spread of fire through the station by compartmentalization.

Fire area boundaries have been defined and evaluated as part of the Salem Fire Protection Program. Construction which does not meet specific rating criteria is either evaluated by an engineering evaluation in accordance with Generic Letter 86-10 or is included in an approved exemption request.

9.5.1.2.2 Penetration Seals

At Salem Generating Station, openings through fire barriers for pipe, conduit, and cable trays which separate fire areas are sealed or closed to provide a fire resistance rating equal to that required of the barrier or have been evaluated and determined adequate to

withstand the fire hazard in the area in accordance with Generic Letter 86-10. In some areas, exemption requests rather than engineering evaluations form the basis for approval of specific seals/openings.

9.5.1.2.3 Fire Doors

Doors that are installed in fire area boundaries carry the UL label, with the exception of oversize doors, which cannot be tested. Fire area boundary doors, enclosing fire areas which are not normally locked, are either provided with a time delay alarm to indicate when the door has been left open, or are routinely inspected. Reliability of the fire doors are enhanced by inspections and administrative controls, which ensure the operability of the fire doors.

PSE&G has been granted a generic exemption from the requirements of 10 CFR 50 Appendix R Section III.G.2(a) which allows the use of 1-1/2 hour fire rated doors in 3 hour barriers based on maintaining a limited combustible loading in the affected areas.

9.5.1.2.4 Fire Dampers

At Salem Generating Station, 1-1/2 hour and 3 hour rated fire dampers are installed in locations where HVAC ducts pass through fire area boundaries. Most of the fire dampers installed at Salem Generating Station are located within the HVAC duct and are not within the plane of the penetrated fire barrier.

PSE&G has either 1) been granted a generic exemption from the requirements of 10 CFR 50 Appendix R Section III.G.2(a) which allows this installation as well as the use of 1 - 1/2 hour fire rated dampers, 1 hour rated ventilation ducts and ventilation duct penetration seals in 3 hour barriers based on maintaining a limited combustible loading in the affected areas or 2) performed an engineering evaluation in accordance with Generic Letter 86-10 to demonstrate the installation is adequate for the hazard.

9.5.1.2.5 Cable Wrap

Cable wraps are used at Salem Generating Station to enclose redundant cabling.

The cable wraps used at Salem are qualified as 1-hour electrical raceway fire barrier systems in accordance with the guidance of Supplement 1 to Generic Letter 86-10.

9.5.1.2.6 Partial Height, Partial Length Marinite Walls

At Salem Generating Station, partial height, partial length marinite walls are used to separate equipment needed for safe shutdown in the Lower Electrical Penetration Area (Fire Areas 1&2FA-EP-78C).

The technical justification for these partial walls separating safe shutdown equipment is provided in an approved exemption request.

9.5.1.2.7 Reactor Coolant Pump Oil Collection System

The Reactor Coolant Pump Bearing Lube Oil Lift Pumps are protected with fixed water fire suppression systems. The discharge from these systems is directed to four reactor coolant pump oil drain tanks that are designed to act as oil skimming tanks. These tanks retain the oil and allow the water to drain to the Containment Sumps.

In addition, a Reactor Coolant Pump Lube Oil Collection System is provided. The oil collection system is engineered, designed and installed so that there is reasonable assurance that its failure will not lead to fire during normal or design basis accident conditions. The oil collection system consists of a series of collection pans and drainage piping that is capable of collecting lube oil from potential pressurized and unpressurized leakage points in the reactor coolant pump lube oil system. Oil leakage is drained and collected to vented closed containers. A flame arrester is provided in the vent system of the oil collection tanks.

9.5.1.2.8 Radiant Energy Shields

Inside Containment, concentrations of electrical cables converge at the electrical penetration areas. Radiant energy shields are placed between the divisions so that radiant energy from a fire involving the cabling of one division would not damage cables of the other divisions.

9.5.1.2.9 Electrical Cable Construction

Tests have been performed to demonstrate the flame retardant properties of the cables used at Salem Generating Station in accordance with or equivalent to IEEE 383, or the UL single conductor test.

Short sections of non-qualified cable may be used for lighting or communications circuits, or may be contained within vendor supplied panels or conduits.

9.5.1.3 Safe Shutdown Capability

For the Salem units, the term "post-fire safe shutdown" refers both to the capability to achieve and maintain hot standby, as well as the capability to achieve and maintain cold shutdown. To demonstrate a post-fire safe shutdown capability, a number of discrete tasks were performed. For the first task, a safe shutdown methodology was established. The safe shutdown methodology essentially provides a scenario for shutting down the plant, i.e., the process by which reactivity is controlled and decay heat is removed. Utilizing the shutdown methodology, the systems (i.e., Auxiliary Feedwater) and components (pumps, valves, etc.) within the systems, necessary for safe shutdown, were identified for the second task.

Concurrent with this task, the plant has been subdivided into "fire areas." The fire-rated boundaries provide reasonable assurance that a fire will be confined to the specific plant sections and will not spread beyond the boundaries. Because fire areas restrict the spread of fire, the overall task is reduced to demonstrating a post-fire shutdown capability for any one particular area at a time.

Utilizing both the fire areas and the identified shutdown components, the next task was to identify circuits/cables necessary to operate these components along with the conduit and raceway routing of the cables. The conduits and raceways were then identified as to which fire area they were located. With the shutdown methodology and fire area boundaries defined and the location of components and cables identified, the final task, the process of fire area assessments, was then performed.

The fire area assessment evaluated the components and cables within a particular fire area to determine if the capability to achieve and maintain safe shutdown existed.

The following compliance strategies were evaluated:

1. Compliance with III.G.1.a – One success path of hot shutdown equipment is free of fire damage from either the control room or an emergency control station (manual action).
2. Compliance with III.G.1.b – Cold shutdown equipment could be repaired within 72 hours.
3. Compliance with III.G.2 – Appropriate separation, fire enclosures, suppression and detection systems are provided in the area of concern.
4. Compliance with III.G.3 – Alternative shutdown capability is provided.

The results of these tasks are discussed in the sections below.

9.5.1.3.1 Development of the Safe Shutdown Model and Identification of Systems and Components

The shutdown model provides the overall methodology for shutting down the plant in the event of a fire. In developing a shutdown scenario, the following assumptions and initial conditions were utilized as follows:

a. At any give time, only one fire would occur (i.e., if a fire were to occur at Salem Unit 1, a fire is not postulated to occur simultaneously at Salem Unit 2).

b. A fire could not occur concurrent with other plant accidents or severe natural occurrences (seismic events).

c. During the course of the post-fire shutdown, the plant would not experience an additional, random single active failure.

These assumptions are consistent with the requirements of Appendix R. Further, the shutdown scenario considered that the units were operating at full power conditions and that offsite power may be available or unavailable for 72 hours. An evaluation was performed for the Salem plant to determine whether or not offsite power would be lost in each fire area.

For fire areas that rely on equipment (for example CVCS cross-tie, HSD Panel cross-tie, Service Water cross-tie) from the opposite unit (non-fire unit) to support post-fire shutdown of the unit experiencing the fire, an accident on the non-fire unit is not assumed to occur. An orderly shutdown of the non-fire unit will be performed when accident mitigation equipment is utilized from the non-fire unit for a prolonged period of time to support the post-fire shutdown of the unit experiencing the fire. Appropriate technical specification actions for the non-fire unit are entered for the accident mitigation equipment that is utilized to support the fire affected unit.

The shutdown model scenario addresses the Appendix R criteria for achieving and maintaining hot standby and cold shutdown conditions through the five basic performance goals delineated in Section III.L of Appendix R. The performance goals for post-fire shutdown are reactivity control, reactor coolant inventory control, decay heat removal, process monitoring and support functions. A sixth performance goal of reactor coolant system pressure control is inferred from the basic five performance goals. These performance goals are discussed in Programmatic Standard DE-PS.ZZ-0001-A3-SSA, "Salem Fire Protection Report – Safe Shutdown Analysis".

9.5.1.3.2 Identification of Cables

As part of the Appendix R safe shutdown analysis process, a cable identification methodology was established to identify any cable that would be required for operation of a safe shutdown component or whose fire-induced damage may result in spurious actuation of a safe shutdown component. These cables are referred to as "safe shutdown cables". The process for identification of safe shutdown cables is discussed in Programmatic Standard DE-PS.ZZ-0001-A4, "Salem Fire Protection Report – Safe Shutdown Cables".

The cable routings are traced to their termination or to an isolation device that would prevent the feedback of faults or spurious signals. Power cables are traced back to the switchgear, MCC, or distribution panel. The switchgear, MCC, and distribution panels are considered as separate components and devices.

The above process was utilized for all devices and fire areas, except for the Diesel Generator Rooms and for the Safeguards and Solid State Protection Signals. Numerous cables exist between the diesel generators and their control panels. For the most part, the wiring between the engine and generator and the control panels are contained within the respective fire areas. Therefore, only those cables which were routed outside the respective diesel generator and control panel areas were recorded on input forms and subsequently their routes traced throughout the plant. For devices associated with the Safeguards and Solid State Protection Signals, cabling was traced back to the cabinet or panel which provides the protective function.

9.5.1.3.3 Associated Circuits

9.5.1.3.3.1 Common Power Supply

The post-fire safe shutdown equipment is powered from the various levels of the vital and non-vital power distribution system. Associated circuits with a common power source would, then, be limited to non-shutdown loads (loads which are not utilized for shutdown, such as containment spray pumps) from the vital buses. The non-vital buses are electrically separated from the vital buses. In general, electrical protection has been applied to all loads of the vital buses. Thus, the vital buses are electrically protected from the non-shutdown loads by coordinated breakers and fuses. In those instances where complete coordination has not been applied, the non-shutdown loads were considered equivalent to shutdown circuits and subjected to the separation/protection requirements of Section III.G of Appendix R. In some fire areas where non-vital loads are utilized for post-fire safe shutdown, the non-vital busses are electrically separated from these fire areas thus ensuring coordination from non-safe shutdown loads.

9.5.1.3.3.2 Spurious Operations

For the spurious operation case of associated circuits, it was necessary to demonstrate that fire induced spurious actuation of equipment would not adversely impact the ability to achieve and maintain safe shutdown. The shutdown model identified for each shutdown function and flow path, those components whose spurious operation would adversely impact the particular function and/or flow path. These components were then treated as safe shutdown components. For example, if the spurious closure of a valve would block a service water flow path, then that valve was considered necessary for operation of that flow path. For each fire area, the unprotected spurious operation components were evaluated to Generic Letter 86-10 and 81-12 criteria. The cabling for these components was also evaluated with respect to the ability of fire-induced failures that could result in spurious actuations of the component. The cable failure modes considered included hot shorts, open circuits and shorts to ground. Power cables for motor-operated valves that do not have to be repositioned were not protected since loss of those cables cannot cause the valve to change position.

Special consideration was given to the valves comprising high-low pressure interfaces.

For the high-low pressure interfaces, five sets of interfaces were identified and evaluated, as follows: the pressurizer PORV and block valve lines, the reactor head vent lines, the residual heat removal suction lines, the letdown lines and the excess letdown lines. Further details of the high-low pressure interface valves is discussed in Programmatic Standard DE-PS.ZZ-0001-A3-SSA, "Salem Fire Protection Report – Safe Shutdown Analysis".

9.5.1.3.3.3 Common Enclosure

For the common enclosure case of associated circuits, it was necessary to demonstrate that fire-induced failure in non-shutdown cables would not electrically or physically propagate a fire to the shutdown cables. Design criteria provides for field routed cabling to meet IEEE-383 requirements. Essentially the cabling utilized will not result in propagation of a fire. As part of the safe shutdown cable identification process, cabling directly connected to the circuit of a safe shutdown component was considered part of the circuit unless it was separated by an isolation device. Thus, any non-electrically isolated circuit is considered part of the safe shutdown cables.

In addition, the cable separation requirements for Salem eliminates a common enclosure concern related to cable installation. The vital channels, "A," "B," "C," and "D" are required to be routed in separate trays and conduits. The electrical divisions 460V, 230V, and 4kV power are also required to be routed in a separate tray or conduit. In addition, channels of non-vital cabling "H," "E," "F," and "G" are designated such that they are routed with only one particular vital channel. Further, the rating of the cables utilized in the Salem units are such that fire-induced shorting or grounding would result in a blown fuse or a tripped breaker before significant degradation of the cabling itself.

9.5.1.3.4 Alternate Shutdown Capability

For the Salem units, alternate shutdown capability is utilized for the Control Room Complex, the Relay Rooms, the 460V Switchgear Rooms, the 4160V Switchgear Rooms, the Reactor Plant Auxiliary Equipment Areas (64’ and 84’ elevations), and the 11 and 21 Component Cooling Pump Rooms. The alternate shutdown capability is primarily procedural control of the same post-fire shutdown equipment utilized for the other plant areas with the exception of the CVCS cross-tie, ASDS inverter cross-tie, the Service Water cross-tie and the use of Main Feedwater. The CVCS system cross-tie is discussed in detail in Section 9.3.4.

The Hot Shutdown Panel has the capability to transfer electric power from the unaffected unit to the unit experiencing the fire in the event that the normal AC power feed to the Hot Shutdown Panel is lost due to the fire.

Operating procedures were developed to accomplish individual functions (pump start/stop operation, valve open/close operation, diesel operations, etc.) for use by the operator as necessary. The procedures can be accomplished utilizing onsite shift personnel, exclusive of the fire department personnel. The onsite shift personnel staffing for post-fire shutdown is controlled by administrative procedure. Emergency lighting is provided to implement the shutdown process. The manual actions performed to achieve Hot Standby are evaluated for feasibility (accessibility, habitability, emergency lighting).

As discussed in detail in the following sections for each fire area, certain alternate shutdown areas require the utilization of equipment from the opposite unit to perform cold shutdown functions. These cold shutdown evolutions consist of either use of the installed service water cross-tie or running temporary power cables from the opposite unit to facilitate bringing the fire affected unit to cold shutdown. Prior to use of equipment from the non-fire unit to perform cold shutdown functions in the fire unit, the non-fire unit will commence an orderly shutdown and be placed in a mode where the equipment is not required for accident mitigation.

9.5.1.4.3.1 Control Room or Relay Room Scenarios

A fire in either of these areas may require the evacuation of the Control Room. The ability to achieve and maintain Hot Standby and Cold Shutdown for these areas consists of the use of normal shutdown systems controlled from emergency control stations (Hot Shutdown Panel and local manual actions).

9.5.1.4.3.2 4160V and 460V Switchgear Room Scenarios

A fire in either of these areas may require the evacuation of the Control Room. The ability to achieve and maintain Hot Standby and Cold Shutdown for these areas consists of the following:

- Use of the Chemical and Volume Control System (CVCS) cross-tie from the unaffected unit for seal injection, boration, and inventory control during the shutdown process.
- Use of the Service Water System “test header” aligned from the opposite unit to provide cooling to the CCW heat exchangers to support RHR system operation for Cold Shutdown.
- Use of a CCW and RHR pump powered from the opposite unit’s switchgear (by a Cold Shutdown repair to route a power cable from the opposite unit’s switchgear to the pump motors).
- Cross-connecting the ASDS power supply from the opposite unit to the HSD panel to support the shutdown process.

9.5.1.3.4.3 Reactor Plant Auxiliary Equipment Area, Elev. 84’ Scenarios

The ability to achieve and maintain Hot Standby from the Control Room for this area consists of the following:

- Use of the Chemical and Volume Control System (CVCS) cross-tie from the unaffected unit for seal injection, boration, and inventory control during the shutdown process.
- Use of off-site power. The use of off-site power, in lieu of on-site emergency diesel generators, is considered an acceptable alternative to the requirements of Section III.L.3 of 10CFR50 Appendix R (See section 9.5.1.4.5.2.a).
- Use of the Main Feedwater system for decay heat removal.
- Use of the Service Water System as described below.

Other than the CVCS cross-ties and the Main Feedwater system, Hot Standby will be achieved using normal shutdown systems.

The service water system cabling for all six service water pumps is routed through this area. To ensure the availability of the service water for Hot Standby, an evaluation has been performed that demonstrates that at least two service water pumps would remain available due to a distance separation of over 75 horizontal feet with intervening combustible loads. This distance separation ensures that either the A-channel service water pumps or the B and C-channel service water pumps would remain available.

9.5.1.3.4.4 11 and 21 Component Cooling Pump Area, Elev. 84' Scenarios

The ability to achieve and maintain Hot Standby for this area consists of the use of alternate shutdown capability, independent of the fire area, in the form of the CVCS cross-tie from the unaffected unit for seal injection, boration, and inventory control during the shutdown process.

Other than the CVCS cross-tie, Hot Standby will be achieved using normal shutdown systems.

9.5.1.3.4.5 Reactor Plant Auxiliary Equipment Area, Elev. 64' Scenarios

The ability to achieve and maintain Hot Standby for this area consists of the following:

- Use of alternative shutdown capability, independent of the fire area, in the form of the CVCS cross-tie from the unaffected unit for seal injection, boration, and inventory control.
- Use of off-site power. The use of off-site power, in lieu of on-site emergency diesel generators, is considered an acceptable alternative to the requirements of Section III.L.3 of 10CFR50 Appendix R (See section 9.5.1.3.5.2.b).

Other than the CVCS cross-tie, Hot Standby will be achieved using normal shutdown systems.

The ability to achieve and maintain Cold Shutdown for this area includes repairs to restore power to CCW system components and alignment of the Service Water cross-tie.

9.5.1.3.5 10CFR50 Appendix R Exemption Requests and Deviations

PSE&G has received NRC approval of exemptions and deviations from the applicable requirements of Appendix R. The exemptions and deviations which have been granted by the NRC are described in Safety Evaluation Reports (SERs) and summarized below:

a. Generic Exemption Station Wide

This exemption is from Section III.G.2a to the extent that 1-1/2 hour fire rated doors and dampers, 1 hour fire-rated ventilation ducts and their penetration seals, and non-rated equipment hatches do not provide 3 hour

fire-rated barriers between areas containing redundant shutdown systems, equipment, cables and associated circuits.

Current Status: Granted 7/20/89. Active.
Exemption no longer necessary in current revision to DE-PS.ZZ-0001(Q) SFPR-SSA for fire areas FA-DG-84F, FA-DG-84G and FA-DG-84H

b. Control Room Complex (Area 12 FA-AB-122A)

This exemption is from Section III.G.3 of Appendix R to 10 CFR Part 50 to the extent it requires a fixed fire suppression system for an area where alternate shutdown capability is provided. Specifically, the Salem Units 1 and 2 Control Room Complex does not have a fixed fire suppression system.

Current Status: Granted 7/20/89. Active.

c. Reactor Plant Auxiliary Equipment Area - Elevation 100 ft. and 110 ft. Upper Electrical Penetration Area (Areas 1 and 2 FA-EP-100G) Inner Piping Penetration Area (Areas 1 and 2 FA-PP-100H)

These exemptions are from the requirements of Section III.G.2 of Appendix R to 10 CFR Part 50 in the above-referenced areas to the extent that it requires the separation of redundant safe shutdown cables and equipment by 1 hour fire-rated barriers plus automatic fire suppression and detection systems. Specifically, these locations are not protected by automatic fire suppression systems or area-wide fire detection systems.

Current Status: Exemption requests for Fire Areas 100G and 100H were withdrawn in 1998.

d. Reactor Plant Auxiliary Building – Elev. 64 ft. Areas 1 and 2 FA-AB-64B

This exemption/deviation is from the requirements of 10CFR50 Appendix R, Section III.G.3 to the extent that a fixed suppression system is not installed for an area where alternative shutdown capability is provided. Specifically, Fire Area 1 (2)-FA-AB-64B, Reactor Plant Auxiliary Building – Elevation 64', is not provided with a fixed suppression system.
In addition, an exemption/deviation from the requirements of 10CFR50, Appendix R, Section III.L.3 to the extent that alternative shutdown capability must accommodate conditions where offsite power is not available for 72 hours. Specifically, Fire Area 1 (2)-FA-AB-64B, Reactor Plant Auxiliary Building – Elevation 64', relies upon offsite power for alternative shutdown capability.

Current Status: Unit 1 Exemption granted 6/24/03.
Unit 2 Deviation granted 1/7/04.

e. Mechanical Penetration Areas (Fire Areas 1 and 2 FA-MP-78I)

This exemption is from Section III.G.2 of Appendix R to 10CFR50 to the extent it requires the separation of redundant cables and equipment by 1 hour rated fire barriers plus area-wide suppression and detection. Specifically, Fire Areas 1 and 2 FA-MP-78I are not protected by automatic suppression systems and area-wide detection capability.

Current Status: Granted 7/20/89. Active
Exemption no longer necessary in current revision to DE-PS.ZZ-0001 (Q) SFPR-SSA for Fire Area FA-MP-78I.

f. 460V Switchgear Room (Areas 1 and 2 FA-AB-84A)
Lower Electrical Penetration Area (Areas 1 and 2 FA-EP-78C) 4160V Switchgear Room (Areas 1 and 2 FA-AB-64A)

These exemptions are from the requirements of Section III.G.2 of Appendix R to 10 CFR Part 50 in the above-referenced areas to the extent that it requires the separation of redundant safe shutdown equipment by 1 hour fire-rated barriers plus automatic suppression and detection systems. Specifically, redundant safe shutdown systems are not protected by complete, 1-hour fire barriers. In addition, the fire suppression system in the 4160V Switchgear Room is manually actuated.

Current Status: Granted 7/20/89. Active (remains in effect for Fire Area FA-EP-78C)
Exemptions are no longer necessary in current revision to DE-PS.ZZ-0001 (Q) SFPR-SSA for Fire Areas FA-AB-64A and FA-AB-84A.
The fire suppression system in the 4160V Switchgear Room is automatically actuated.

g. Reactor Plant Auxiliary Equipment Area - Elevation 84 ft. (Areas 1 and 2 FA-AB-84B)

This exemption/deviation is from the requirements of 10CFR50, Appendix R, Section III.L.3 to the extent that alternative shutdown capability must accommodate post fire conditions where offsite power is not available for 72 hours. Specifically, Fire Area 1 (2) FA-AB-84B, Reactor Plant Auxiliary Equipment Area – Elevation 84’, relies upon offsite power for alternative shutdown capability. This area also relies on spatial separation for cables associated with the service water system to ensure post-fire operation of a minimum of two service water pumps.

Current Status: Unit 1 Exemption granted 6/24/03.
Unit 2 Deviation granted 1/7/04.

h. Residual Heat Removal Pump and Heat Exchanger Areas (Areas 1 and 2 FA-AB-45A and B)

This exemption is from the technical requirements of Section III.G.2 of Appendix R to 10 CFR Part 50 to the extent that it requires the separation of redundant safe shutdown systems by complete 3 hour fire-rated barriers. Specifically, redundant cables in these areas are separated by 3 hour fire rated walls with open penetrations.

Current Status: Granted 7/20/89. Active

i. Containment (Areas 1 and 2 FA-RC-78)

This exemption is from the requirements of Section III.G.2 of Appendix R to 10 CFR Part 50 to the extent that it requires that redundant cables and equipment within containment be separated by at least 20 feet of horizontal distance free of intervening combustibles or be separated by a radiant energy shield.

Current Status: Granted 7/20/89. Active

j. Pipe Tunnel - Elevation 84 feet (Area 12 FA-PT-84)

This exemption is from the technical requirements of Section III.G.2 of Appendix R to 10 CFR Part 50 to the extent that it requires that redundant shutdown systems be separated by at least 20 feet free of intervening combustibles and be protected by automatic fire detection and suppression systems. Specifically, redundant systems are separated by less than 20 feet and the tunnel is not protected by an automatic fire suppression system.

Current Status: Granted 7/20/89. Active

k. CO_2 Equipment Room - Elevation 84 feet (Areas 1 and 2 FA-DG-84F)

This exemption is from the technical requirements of Section III.G.2 of Appendix R to 10 CFR 50 to the extent that it requires separation of redundant shutdown systems by 1 hour fire barriers and protection by automatic fire detection and suppression systems. Specifically, redundant shutdown cables are not protected by an automatic fire suppression system.

Current Status: Granted 7/20/89. Active
Exemption no longer necessary in current revision to DE-PS.ZZ-0001 (Q) SFPR-SSA for Fire Area FA-DG-84F.

l. Reactor Plant Auxiliary Equipment Area – Elevation 100 feet (Areas 1 and 2 FA-AB-100C)

This exemption is from the technical requirements of Section III.G.2 of Appendix R to 10CFR50 to the extent that it requires separation of redundant shutdown systems by 1 hour fire barriers and protection by automatic fire detection and suppression systems. Specifically, redundant shutdown cables are not protected by an automatic fire suppression system.

Current Status: Granted 7/20/89. Active
Exemption no longer necessary in current revision to DE-PS.ZZ-0001 (Q) SFPR-SSA for Fire Area FA-AB-100C.

m. 11 (21) Component cooling Pump Area – Elevation 84 ft. (Areas 1 and 2 FA-AB-84C)

This exemption/deviation is from the requirements of 10CFR50 Appendix R, Section III.G.3 to the extent that a fixed suppression system is not installed for an area where alternative shutdown capability is provided. Specifically, Fire Area 1 (2)-FA-AB-84C, Component Cooling Water 11 (21) Pump and Heat Exchanger Area – Elevation 84’, is not provided with a fixed suppression system.

Current Status: Unit 1 Exemption granted 6/24/03.
Unit 2 Deviation granted 1/7/04.

9.5.1.5 Support Equipment

9.5.1.5.1 Emergency Lighting

The lighting system at Salem Generating Station consists of normal lighting, emergency lighting, self-contained emergency battery lighting, and portable hand held lights. A description of the complete system is contained in Section 9.5.3.1 of the Salem UFSAR.

The emergency lighting provided for Appendix R safe shutdown is a self-contained lighting system consisting of fixed and portable hand held lights. Each lighting unit consists of a battery, charger, lights and electronics and it is rated to supply 8 hours of lighting.

The fixed lighting units are energized automatically upon a loss of power and they are located in access routes to and within areas where shutdown functions must be performed.

The portable hand held lighting units are located in the Appendix R locker and they are used as a supplement to the fixed lighting units and for exterior access and egress to operate safe shutdown equipment outside the power block.

9.5.1.5.2 Portable Radios

A portable radio communication system as described in Section 9.5.2 of the Salem UFSAR is provided for use of the fire brigade as well as operations personnel involved in emergency activities. This system does not interfere with the communication equipment of the security force. For post fire safe shutdown, the operators will use portable hand held radios. The radio system including repeaters and power supplies has been designed to be available for a fire in any of the alternate shutdown areas.

9.5.1.5.3 Ventilation and Smoke Removal

Ventilation systems for the station were not specifically designed to provide automatic smoke and heat venting. Natural convection type ventilation is not used at this station. The station ventilation systems provide forced-convection flows for specific areas. Smoke and corrosive gases from a fire may be discharged directly to the outdoors by nature of the once-through ventilation design applied throughout the station (with the exception of the Reactor Containment).

Ventilation systems serving the safety related areas are controlled from the Control Room. A special part of the

Control Area Air Conditioning System, designated Emergency Air Conditioning System (EACS) contains special equipment to ensure habitability of the Control Room under all operating conditions.

9.5.1.6 Fire Detection

9.5.1.6.1 Fire Detection and Alarm System

The Salem Generating Station fire detection and alarm systems are designed and installed as a "Class B" supervised signaling system. The system is not a safety related system and is not designed to record system signals.

The primary purpose of the proprietary protective signaling system is to detect fire during its early stages of development and initiate an alarm to minimize the adverse impact of fire on buildings, systems, and components. In addition, these signal systems provide release of selected extinguishing systems.

Annunciation functions are displayed on the Fire Protection System Panel in each Control Room. The overhead annunciator in each Control Room indicates alarm and trouble signals, as well as loss of DC power.

Several different types of fire detectors are used at Salem Generation Station. The majority of detectors are ionization chamber smoke detectors. The detection system also utilized other types of fire detectors such as rate of rise, fixed temperature heat detectors, photoelectric, and rate compensated detectors.

The number and placement of fire detectors was determined by considering the configuration of the space protected. NFPA 72E, Automatic Fire Detectors, was used as a guideline for the placement of fire detectors except where alternative spacing was judged acceptable by a Member grade fire protection engineer.

All of the fire detection systems are of the Class B supervised circuit type.

9.5.1.7 Fire Suppression Systems

9.5.1.7.1 Water Supply

Fresh water for fire protection is stored in two independent fresh water storage tanks. Each tank has a capacity of 350,000 gallons; 300,000 gallons of which are reserved for fire protection use and 50,000 gallons available for domestic service. The largest system demand is 1544 gpm at 74 psig for a main power transformer. Each tank is therefore capable of supplying the greatest system demand plus an additional 500 gpm for hose streams for a minimum of 2 hours, representing 100% redundant capacity.

Two redundant diesel driven fire pumps are provided at Salem Generating Station, each rated for 2500 gpm at 135 psig. Each pump has its own driver with independent power supplies and controls mounted on a structural steel base and controlled by a combined manual and automatic panel. In addition, a pressure maintenance (jockey) pump provides system pressurization.

The fire pump suction piping and valve arrangement allows either pump to take water from either or both fresh water storage tanks. Isolation valves have been provided in the supply headers.

A separate discharge header from each fire pump connects to the underground yard fire main loop which encircles the station.

The two fire pumps and their associated fuel oil day tanks are located in one room. The room is provided with a wet pipe sprinkler system. Floor drains are provided which would limit the spread of oil in the event of a leaking oil tank. Each fire pump is mounted on a 12-inch high concrete pedestal. These alternative fire protection provisions were found acceptable by the NRC in lieu of locating the fire pumps in separate fire areas.

The pressure maintenance pump is used to supply water to makeup for minor system leaks, and to avoid frequent starting of the fire pumps from minor system fluctuations. Should the jockey pump be unable to maintain pressure, and the system pressure falls, the first fire pump automatically starts. Once this pump starts, it will continue to run until it is manually shut off at its control cabinet located in the Fire Pump House. Should the first fire pump fail to start or if there is a large demand for fire water, and the system pressure continues to fall, the second fire pump automatically starts to maintain system pressure. The second fire pump will also continue to pump until it is manually shut off at its control cabinet in the Fire Pump House. The fire pumps can only be stopped at the fire pump controller with the manual switch.

Each of the fire pumps is equipped with operating alarms which appear on the fire pump Control Cabinet, and any one of these alarms will also sound the trouble alarm on the Unit 1 Control Room overhear annunciator.

The fire pumps discharge into an underground main surrounding the plant. Fire hydrants, installed in the station yard areas, tie into the fire main loop. Each hydrant is equipped with two 2-1/2 inch hose connectors. The hydrants are located strategically within the protected area. Hoses and associated equipment are provided by mobile means such as trucks and/or hose carts. The quantity of mobile equipment is equivalent to the equipment that would be supplied by three hose houses per NFPA 24. A looped header located inside the plant buildings is also supplied from the underground loop. Connections from the underground distribution main enter the Turbine and Auxiliary Buildings to supply a header at the perimeter of the Turbine-Generator area, and another header through the center of the Auxiliary Building. The pipe is sectionalized by valves which permit the use of selected lengths in the event any section of piping is damaged. The indoor header supplies fire water to the various deluge water spray systems, sprinkler systems and standpipes located throughout the Auxiliary Building Containment, Turbine Generator area, Service Building, Administrative Building and main transformer area.

Approved post indicator type valves or curb valves are provided in the yard main and in supply headers to the buildings to allow for isolating hydrants and portions of the piping system during maintenance and repair periods without shutting off the entire system. Each sprinkler, deluge and standpipe supply line is equipped with an approved gate valve. Valves in supply lines to fire water sprinkler systems, deluge system, and standpipe valves located inside buildings, are locked in the correct position and periodically checked by surveillance or periodic test procedures. Hose standpipe isolation valves and yard main post indicators are provided with locking devices. Supervision of key operated hydrant isolation valves (curb valves) which are not locked is maintained by strict control of the key wrenches which have been assigned to responsible station personnel. In addition, visual checks of all valves are performed periodically.

9.5.1.7.2 Sprinkler and Water Spray Systems

Three types of water based suppression systems are utilized at Salem Generating Station:

- o Wet Pipe Sprinklers
- o Dry Pipe Sprinklers
- o Water Spray Systems

All systems are provided with alarms in the Control Room which indicate system operation.

The locations for each type of system are as follows:

- o Wet Pipe Sprinklers

  Closed head wet pipe sprinkler systems are installed in the following areas:

1. Service Building - Elevations 88, 100, 113, and 127

2. Fire Pump House - Elevation 100

3. Heating Boiler House - Elevation 100

4. Turbine Perimeter - Elevations 88, 100, and 120

5. Auxiliary Building Drumming & Baling Storage Area, and Truck Bay

6. Auxiliary Building Resin Storage Area

7. Cable Vaults carrying cable between the Auxiliary Building and Turbine Building

8. Clean facilities building 0 Elevations 100, 119, and 132.

9. Auxiliary Building Charging and Safety Injection Pumps - Elevation 84

10. Deleted

11. Administration Building, Elevation 100

o Dry Pipe Sprinklers

Two closed head dry pipe pre-action type sprinkler systems are provided for the protection of the Auxiliary Feedwater Pumps on Elevation 84'. One system is electrically actuated and the other is pneumatically actuated in order to provide redundant protection.

Three closed dry pipe pre-action type sprinkler systems are provided for the protection of the 460V Switchgear Room (Areas 1FA-AB-84A and 2FA-AB-84A), Lower Electrical Penetration Area (Areas 1FA-EP-78C and 2FA-EP-78C), and the 4160V Switchgear Room (Areas 1FA-AB-64A and 2FA-AB-64A). All three systems are electrically actuated on fire/smoke detection and concurrent loss of supervisory air.

o Water Spray Systems

Water spray systems consisting of open head deluge systems automatically released by either water (hydraulic), air (pneumatic), or electrical mechanisms are provided in the following locations:

Water Release Water Spray Systems

Water spray systems which are automatically actuated are provided for the following equipment:

1. Turbine lubricating oil makeup tank.

2. Turbine lubricating oil storage tanks.

3. Turbine lubricating oil reservoir, coolers, and conditioner.

4. Seal oil unit.

5. Feedwater pump turbine lubricating oil coolers and tank.

6. Station air compressors.

Pneumatic Release Water Spray Systems

Water spray systems actuated by pneumatic air-pilot line sprinklers are provided for the following equipment:

1. Generator main transformer banks.

2. Auxiliary power transformers.

3. Station power transformers.

4. Heating boiler fuel oil pump and heater.

5. Reactor coolant pump lubricating oil lift pump and discharge lines.

6. Turbine and inboard generator bearing housings.

Electrical Release Water Spray Systems

Water spray systems actuated by continuous strip thermal detectors are provided for the following charcoal filter banks:

1. Control Room emergency air conditioning system.

2. Auxiliary Building exhaust - emergency filter bank.

3. Containment pressure-vacuum relief system.

4. Iodine removal system.

5. Fuel Handling Building Ventilation Unit Charcoal filters.

Water spray systems activated by thermal detectors are provided for the:

1. Diesel Fuel Oil Storage Tank Rooms

9.5.1.7.3 Hose and Standpipe Systems

Hose stations at the Salem Station are provided for the Reactor Containments, Auxiliary Building, Service Building, Turbine Building and Administration Building. Each hose station is equipped with 1-1/2 inch fire hose and an adjustable fog nozzle. Electrically safe nozzles are provided at specified locations. Additional lengths of hose are stored on hose racks at specific locations.

Hose stations are provided for all floors of these buildings, except on Elevation 45 ft. of the Auxiliary Building, and the Fuel Handling Building. These areas can be reached from existing hose stations in other areas.

Hose stations are not provided in the Service Water Pump House. Since access to each of the pump rooms is from outside, a fire hydrant is provided in the yard near the building.

All standpipes are 2-1/2 inch diameter. The individual branch supply to the hose reel is 1-1/2 inch diameter.

9.5.1.7.4 Other Suppression Systems

Foam System

At Salem Generating Station, a manually operated foam fire suppression system protects the Bulk Fuel Oil Storage Tank. This tank is a non-safety related facility, located above ground, outdoors, and approximately 400 feet south of the Turbine-Generator Building

CO_2 Fire Suppression Systems

Low pressure carbon dioxide fire protection systems are provided for the Diesel-Generator Rooms and associated control rooms, day tanks, fuel oil storage tanks and pumps. Each CO_2 tank contains a sufficient supply of carbon dioxide for at least two full discharges into the largest protected area. The largest area protected is the Diesel Generator and Control Room. There are three diesel-generator sets per unit at the Salem Generating Station. Each set is flooded by independent CO_2 actuation. Each Diesel-Generator Room and its associated control room and day tank area are actuated together. The two diesel fuel oil pump rooms for each unit are also actuated together.

Carbon dioxide fire protection for the Generator Exciter Enclosure for each unit is supplied from a separate refrigerated storage tank located in the Turbine Area.

Halon 1301 Fire Suppression Systems

Halon 1301 fire extinguishing systems are provided for the Relay Rooms. Each Relay Room has an independent extinguishing system capable of total discharge of either main or reserve charges of fire extinguishing agent within approximately ten seconds of activation. The Halon systems are designed to be activated either automatically or manually. Automatic actuation occurs upon receipt of signals from both zones of a cross-zone Fire Detection System. Manual actuation is accomplished by using remote pull stations.

A Halon 1301 system is also provided for the protection of the Dimension 2000 Telephone building.

Portable Fire Extinguishers

Portable fire extinguishers are provided at specific locations throughout the station. The selection and spacing of extinguishers at Salem is based upon NFPA 10 guidance for the type of hazard present.

9.5.2 Communications System

The plant Communications Systems provide an effective means to coordinate activities during conditions of normal operation, maintenance and accidents.

9.5.2.1 Page-Party System

The Page-Party System is a completely transistorized voice communication system which is capable of operation in extreme environmental conditions such as dust, moisture, heat, and noise. The system consists of two separate and independently wired communication channels are provided for page and party.

The page channel is connected to all plant loudspeakers with the exception of the Unit 1 and 2 Control Rooms and may be used to call personnel or issue plantwide instructions. Five (5) party lines are available with party line one (1) being dedicated to the Unit 1 Control Room and party line two (2) dedicated to the Unit 2 Control Room. Plant to plant conversations cannot be conducted on these two lines. Party lines one (1) and two (2) being direct connections to the respective control rooms do not require any paging. Party lines three (3), four (4) and five (5) are for plant conversations which can be heard by anyone picking up a handset and selecting the appropriate party line. While one of the party lines is in use, the page channel can be utilized to establish conversations on an unused party line, Simultaneous conversations can take place, one on each channel. Also, a multi-tone generator provides procedural and alarm signals which can be broadcast throughout the plant. Examples of such signals are start and stop whistles, lunch, fire, and radiation alert. The page channel can also be used for direct communication between individual personnel at separate handset locations; however, this conversation will be heard over all unsilenced speakers.

Closed channel communication is provided between fuel loading areas (reactor containment, Fuel Handling Building and Control Room) by means of separately wired page and party lines connected between these locations for closed circuit communications.

Power for the Communication System is 120 V ac, inverted from a dc source. This is to insure the continuous availability of plant wide communications during a power failure and to provide uninterruptible communications with the Newark Load Dispatcher. If the inverter fails, power will be derived from a 230 V ac vital bus.

9.5.2.2 Telephone System

Ten telephones are located in each Control Room. One of them is a direct line to the Load Dispatcher; one is a direct line to the NRC; two are for use with the Centrex Instrument; two are for general purpose use; and four are for NETS. Direct lines are also provided in the Administration Building Conference Room and tie in directly to the New Jersey Bell Telephone Company. These lines are for emergency use and insure communications between the Conference Room and the Telephone Company.

9.5.2.3 Closed Circuit Television System

A closed circuit television system provides intermittent television monitoring of equipment inside containment. Portable underwater television equipment is provided for the Fuel Handling Building and for scanning the inside of large vessels.

Each Containment Building has three television cameras mounted on the containment liner, 120 degrees apart, at an elevation of approximately 205 feet. Each containment camera has a zoom lens and a pan and tilt control unit. A switch is located in the control room for turning the lights in the containment on and off.

Underwater equipment consists of four underwater cameras each with its own zoom lens, pan and tilt unit and 9-inch monitor. Two sets of portable lights are provided for underwater illumination. Monitors and camera controls are mounted on a movable television table.

Video tape recorders are provided with any of the television cameras.

9.5.2.4 Radio Repeater System

A system of portable transceivers and fixed repeaters is provided for the fire brigade.

9.5.3 Lighting System

The Lighting System provides necessary illumination for day-to-day plant operation and adequate illumination for safe shutdown and personnel safety.

9.5.3.1 Emergency Lighting

Power for emergency lighting within the plant is distributed by Lighting Distribution Panels (LDP) 1ELD and 1ELC (2ELD and 2ELC for Unit 2). Lighting Distribution Panels 1ELD (2ELD for Unit 2) contains two separate distribution buses. One bus within LDP 1ELD (2ELD) is supplied either from Lighting Inverter 11 (21) or from 230 V ac vital bus 1A (2A) through a lighting transformer (located inside the inverter enclosure). A bus transfer switch in the output of inverter 11 (21) automatically switches from the inverter output to ac vital bus 1A (2A) if a loss of inverter output power is sensed. Lighting Inverter 11 (21) is powered by battery 1A (2A). The second bus within LPD 1ELD (2ELD) is supplied in a similar manner from Lighting Inverter 12 (22), 230 V ac vital bus 1B (2B), battery 1B (2B), and a bus transfer switch. LDP 1ELC (2ELC) is powered from lighting inverter 13 (23) and 230 V ac vital bus 1C (2C) with automatic switchover accomplished by a bus transfer switch in the same way as described above. Lighting Distribution Panels, 1ELD-A, 1ELD-B, and 1ELC for Unit 1 are normally powered by 230V AC, 3 phase vital buses, 1SWGR1AY, 1SWGR1BY, and 1SWGR1CY through lighting transformers located within the inverter enclosure. The backup power for these LPD's are inverters 11, 12, and 13 which are fed from 125V DC sources, 1SWGR1ADC, 1SWGR1BDC, and 1SWGR1CDC, respectively. Lighting Distribution Panels 2ELD-A, 2ELD-B, and 2ELC for Unit 2 are normally powered by 230V AC, 3 phase vital busses 2SWGR2AY, 2SWGR2BY, and 2SWGR2CY through transformers located within the inverter. The backup power for these LDPs are inverters 21, 22, and 23 which are fed from 125V DC sources 2SWGR2ADC, 2SWGR2BDC, and 2SWGR2CDC, respectively. A bus transfer switch in the output of the inverter will automatically transfer to the inverter output upon the loss of the normal 230V AC vital bus supply.

Areas of the plant requiring operator access for safe shutdown are provided with self-contained emergency lights. These units are battery powered and have an 8-hour capacity. Those self contained emergency light battery supports that are required to meet seismic integrity are designed to withstand seismic forces.

9.5.3.2 Normal Lighting

Power for normal lighting within the plant is distributed through 12 LDPs and 61 lighting panel boards. Normal lighting LDPs in the main plant receive power from 4 kV buses 1H and 1F (2H and 2F for Unit 2) and substations 1HL and 1FL (2HL and 2FL for Unit 2). One lighting panel board in the reactor area of each unit is cross fed from the opposite unit substation (1FL for Unit 2 and 2FL for Unit 1). Most of the lighting panel boards are fed from LDPs; however, LPs serving the following areas receive power from local motor control centers: service water intake area, circulating water intake area, Fire Pump House and Heating Boiler House.

In most areas where mercury vapor or fluorescent lighting is used, such as in the Turbine Building and Auxiliary Building, lighting is switched directly from the LPs. However, in the Reactor Containments, fuel handling areas, Service Building, and Administration Building, special switching arrangements have been provided.

Containment area lighting is controlled by lighting contactors located on Elevation 64 feet in the Auxiliary Building. These contactors can be switched from personnel hatches and from the Control Rooms. Remote switching is provided because of the inaccessibility of the containment areas while the reactors are in operation and the occasional need for closed circuit television surveillance.

Lighting in fuel handling areas (which are normally unoccupied) is controlled from a panel located in the Electrical Equipment Room on Elevation 100 feet. Lighting for building access is controlled from switches located near the Equipment Room doors and at the door on Elevation 130 feet entering staircase No. 10 (No. 1 Unit) and staircase No. 11 (Unit 2).

Conventional commercial building switching arrangements are employed in office and laboratory areas such as those located in the Administration and Service Buildings.

9.5.4 Diesel Generator Fuel Storage and Transfer System

The Diesel Fuel Oil System stores and supplies the diesel generators with No. 2 fuel oil. The system flow diagram is shown on Plant Drawing 205249, and also includes other portions of the fuel oil system. The diesel generator fuel oil system is Class I (seismic).

The two 30,000 gallon (nominal) fuel oil storage tanks per unit are the Seismic Class I source of fuel oil for the diesel generators. These tanks can be filled without disrupting diesel generator operation from the 20,000 barrel fuel oil storage tank or via the emergency fill connection located along the outside wall of the diesel generator rooms. The combined volume of both 30,000 gallon fuel oil storage tanks contains sufficient fuel oil at the Technical Specification minimum volume to supply two diesel generators, operating at the most limiting accident mitigation load profile for LOCA with loss of offsite power, for approximately 4 1/2 days. Operation of two diesel generators beyond this time requires that fuel oil be added to the 30,000 gallon storage tanks from either the on-site 20,000 barrel storage tank or from an off-site source.

Each diesel draws fuel from its own 550-gallon diesel day tank located above the engine on the 120-foot elevation of the Auxiliary Building. Day tanks are accessible only by ladder from the Diesel Engine Room.

Two fuel oil transfer pumps per unit are used to transfer fuel oil to the diesel day tanks from four 30,000-gallon storage tanks located on the 84-foot level of the Auxiliary Building. Each of the fuel oil transfer pumps has a REGULAR-BACKUP selector switch and an OFF-AUTO-MAN selector switch. One of the fuel oil transfer pumps starts at the regular transfer pump start level. A fuel oil day tank level switch starts the back-up transfer pump and provides an alarm on low tank level. The low tank level setpoint is based on maintaining no less than a 60-minute fuel oil reserve at a level that fuel is automatically added. This is consistent with ANSI N195-1976. Should the pump fail to shut off when all tanks are full or should oil in all tanks reach the tank overflow, a level switch will stop the transfer pump and give a

"FUEL OIL DAY TANK LEVEL HIGH" alarm. A gage glass also is installed on the side of each day tank. Each diesel fuel oil pump can be manually controlled from its respective 230-V control center in the event that a postulated fire in a diesel-generator control area results in the loss of both transfer pump control circuits.

Fuel oil is supplied by gravity to the engine-mounted fuel oil booster pump by two parallel lines which join at the inlet to the primary duplex filter. The pump discharges 5 gpm at 40 to 45 psi and a relief valve on the discharge will bypass fuel to the inlet of the pump if pressure exceeds 75 psia. From the pump the fuel is filtered again by the secondary duplex filter and is supplied to the individual fuel oil injection pumps. A pressure regulator maintains fuel oil pressure in the engine fuel oil header. The regulator diverts oil to the day tank if header pressure exceeds 45 psi.

Local pressure gages are provided to read pressure drop across the primary and secondary filters, fuel oil header pressure, and both fuel transfer pump discharges.

Measures have been taken to satisfy the intent of the fuel oil quality assurance requirements of Regulatory Guide 1.137, Position C.2.b. In addition to classifying diesel fuel as a safety-related material within the Salem quality assurance program, the following procedural requirements have been specified:

1. A fuel oil sample is taken from each truck delivering fuel oil to Salem, except when several trucks arrive at once, a minimum of one in four trucks is sampled.

2. All newly received fuel oil is pumped into the 20,000-barrel fuel oil storage tank. Fuel oil in this tank is sampled at least once every 30 days.

3. Fuel oil in each of the four 30,000-gallon diesel fuel oil storage tanks is sampled as required by the Salem Technical Specifications.

4. All fuel oil samples taken in items 1 through 3 above are sent to an independent laboratory within 48 hours of the time the sample was taken. The analysis performed by the laboratory will be consistent with Regulatory Guide 1.137 and ASTM D975-77, and the analysis report is submitted to the Salem Station within 30 days of receipt of the sample at the laboratory. If reports indicate that fuel oil quality is not within acceptable limits, appropriate action will be taken to restore it to within acceptable limits.

5. Fuel oil deliveries, samples taken and related analysis reports will be logged at the station.

9.5.5 Diesel Generator Jacket Water Cooling System

The Jacket Water Cooling System controls the operating temperature of the diesel engine by removing diesel engine heat. The Jacket Cooling Water System is Seismic Class I.

The engine driven jacket water pump circulates cooling water through the engine manifold and turbocharger, to a three-way thermostatically controlled valve. The three-way valve is set to maintain engine water temperature at 170°F. If water temperature sensed at the suction to the jacket water pump is high, the valve automatically directs the system water through the jacket water heat exchanger where it is cooled by the Service Water System. If the water temperature is low, the valve automatically bypasses the jacket water heat exchanger. Temperature switches are provided at the manifold outlet to give a "Jacket Water High Temperature" alarm if water temperature exceeds 175°F and to trip the diesel if water temperature exceeds 195°F (unless a safeguard signal is present).

Makeup water to the Jacket Water Cooling System is supplied to the expansion tank from the station demineralized water system. The makeup water supply to the expansion tank is manually operated due to concerns of the tank overflow and spillage of hazardous water containing corrosion inhibitors. A gage glass and a level switch for an "EXPANSION TANK" and a level switch for an "EXPANSION TANK HI-LO LEVEL" alarm are provided.

Immersion heaters are installed in the engine to maintain water temperature at standby conditions. The heaters are controlled by a temperature switch that energizes the heaters when water temperature decreases below setpoint and de-energizes the heaters when the temperature reaches the setpoint. An alarm annunciates low and high jacket water standby temperature. The Jacket Water System is also supplied with an after-cooler heater. Although not deemed necessary, this 2 kW thermostatically controlled heater provides additional freeze protection in the after-cooler when engines are not in operation.

9.5.6 Diesel Generator Starting Air System

The Starting Air System supplies compressed air to the diesel engine air starting motors. The Starting Air System is Seismic Class I.

The Starting Air System for each diesel generator consists of two motor-driven air compressors and two starting air receiver tanks. Each receiver is sized to hold sufficient air for three cold diesel starts. Compressors are designed for automatic unloading at startup and can operate either in the manual mode or in the automatic mode with unloading controlled by air pressure in the receiver tanks. In addition, the turbo-boost system is required to assist the rapid starting of the diesel to meet the acceptable time requirements for loading.

A pressure switch located at the compressor discharge starts the compressor when receiver air pressure falls below 210 psig and stops the compressor when pressure reaches 245 psig. The discharge line is protected by a relief valve set at 300 psi and the receivers are protected by relief valves set at 275 psi.

Each diesel generator is equipped with two pairs of start motors. Each pair is supplied by a single receiver. In addition, receivers are interconnected so that they can be filled by either or both compressors. If necessary, the diesel can be started by any one pair of air start motors.

Air from the receivers is fed through regulator valves, which reduce pressure to 150 psig, to the air system solenoid valves. At the initiation of a start, the solenoid valves open, supplying air to the motors. The air supply is shut off after ignition has been sensed by pressure switches located on the discharge of the jacket water pump, or by engine speed increasing above determined setpoints. The air supply is also shut off after a pre-determined time delay to prevent excessive loss of starting air pressure.

Testing provisions include the capability to test individually the air start solenoid valves and the turbo-boost solenoid valves.

Low pressure in the air receivers is sensed by pressure switches mounted on the starting air header. This alarm provides time for operator action to investigate the cause for the low pressure in advance of reaching the minimum air receiver pressure for three cold starts. An additional pressure switch is located at the starting air motor inlet header and is set to indicate that the air header pressure is marginal for diesel start requirements.

9.5.7 Diesel Generator Lube Oil System

The Lubricating Oil System circulates, cools and filters lubricating oil for each diesel generator engine. An engine-driven lube oil pump takes suction from the lube oil sump tank in the engine and discharges through the lube oil filter to a three-way thermostatically controlled valve. The three-way valve is designed to maintain the lube oil temperature at about 130°F. If lube oil temperature is higher than 180°F, the valve automatically directs the lube oil through the lube oil heat exchanger where it is cooled by the Service Water System. If lube oil temperature is lower than 180°F, the valve automatically bypasses the lube oil cooler. A temperature switch, at the discharge of the engine driven lube oil pump, gives a "LUBE OIL HIGH TEMPERATURE" alarm if oil temperature exceeds 190°F and trips the engine if oil temperature exceeds 205°F (unless a safeguard signal is present).

From the three-way valve, lube oil passes through a duplex strainer before re-entering the engine and supercharger. Once the lube oil has completed its path through the engine, it is collected in the lube oil sump tank.

A relief valve on the discharge of the main lube oil pump is designed to protect the pump in case of a line restriction by relieving oil to the engine if discharge pressure exceeds 130 psi.

A pressure switch in the main engine lube oil inlet gives a low engine lube oil header pressure alarm. Additional pressure switches are provided to trip the diesel generator if lube oil pressure continues to drop.

A motor-driven prelube pump is automatically started when the diesel generator is tripped and jacket water pressure reaches its low pressure setpoint. The purpose of the prelube pump is to keep the lube oil at near operating temperature and to keep moving parts lubricated, thereby reducing wear when the diesel generator is started. The prelube pump also provides some oil lubrication if the engine trips while at power. Normally load is removed from the engine and it is allowed to idle for several minutes before it is shut down. Idling the engine for several minutes permits the shaft-driven oil pump to circulate oil to the lube oil coolers and then back to the engine.

Lube oil heaters are supplied to maintain lube oil temperature at 120°F for easier starting when engines are in standby condition. A temperature switch located at the inlet to the lube oil filter energizes the heater when lube oil temperature drops below 110°F and shuts off when lube oil temperature rises above 120°F. An

additional temperature switch gives a "LUBE OIL HEATER FAILURE" alarm if lube oil temperature falls below 100°F or rises above 130°F.

Two level switches provide an alarm when crankcase oil level falls to a low level or rises to a high level.

FIGURE 9.5-1 INTENTIONALLY DELETED.

Figure F9.5-2 Sheets 1, 2 & 3 of 3 intentionally deleted.

Refer to plant drawing 205249 in DCRMS